Standardisation
in Companies and Markets

Hesser • Feilzer • de Vries • et al.

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Wilfried Hesser

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Wilfried Hesser

Preface

Since publication of the first issue of this book and the Curriculum on Standardisation in Companies and Markets in 2006, a wide-ranging discussion has been taking place within the "standardisation scene" on the subject of teaching. Many initiatives that have originated from our project are aimed at securing the place for standardisation in education which many experts and academics believe it justly deserves. The objective here is to raise standardisation, particularly in university education, to a subject sui generis, assuming equal status alongside other well-established subjects of study. However, the progress made to date in this respect takes extremely different forms when viewed as part of an international comparison. There is no doubt that Asian countries such as Korea and Japan are playing pioneering roles in this development with their wide-ranging approaches to education policy that have made standardisation an integral part of the curriculum at all levels, from primary school via the university sector through to further education and ongoing training. At the same time, these countries are pursuing a regional Asian approach to standardisation education. By contrast, in other countries, particularly those in the European Union, little more is offered than the further education services provided by the respective national standards bodies, with standardisation often playing only an insignificant role or no role at all in the university sector. While the representatives of the European Union may well be aware of the importance of standardisation, the results of a series of consultations and workshops on this topic suggest that no EU-funded approach is to be expected in this field.
Nevertheless, the overwhelming majority of experts regard an improvement in standardisation education as urgently needed in all fields because standardisation plays such a key technical and socio-economic role in today's industrial and information society. Technologically advanced fields with high economic growth potential, in particular, have a permanent need for high-quality standards and excellent qualifications. A broad-based level of qualification, in other words expertise, is mainly based on an appropriate educational concept. Unless a future-oriented strategy in standardisation education is in place to take account of the demand, the consequences will be missed opportunities for growth or structural breaks at the technical and social level. We see developments in the Asian region as confirmation of our multidisciplinary and interdisciplinary approach and hope that, through this curriculum, we will be able to help standardisation achieve a higher status within education. We wish the reader a great deal of pleasure when studying this third edition, which now includes four new study units and has undergone extensive revision in a number of sections.

Wilfried Hesser

Vorwort

Seit der Veröffentlichung der ersten Auflage des Buches und des Curriculums zur Standardisation in Companies and Markets im Jahre 2006 hat in der „Standardisierungs-Szene" eine starke Diskussion zur Lehre stattgefunden. Viele Initiativen deren Ausgangspunkt sich aus unserem Projekt begründet, zielen darauf ab, der Standardisierung den Platz in der Ausbildung einzuräumen, der ihr nach Ansicht vieler Experten und Wissenschaftler gebührt. Zielsetzung hierbei ist es die Standardisierung insbesondere in der universitären Ausbildung zu einem Fach sui generis zu erheben, das gleichberechtigt neben anderen wohl etablierten Fächern steht. Die Fortschritte, die dabei bisher gemacht wurden, gestalten sich im internationalen Vergleich allerdings durchaus unterschiedlich. Eine Vorreiterrolle spielen hierbei zweifelsohne asiatische Länder wie Korea und Japan, die mit umfassenden bildungspolitischen Ansätzen die Standardisierung auf praktisch allen Bildungsebenen von der Grundschule über die universitäre Ausbildung bis zur Weiterbildung zu einem integralen Bestandteil der Ausbildung gemacht haben. Diese Länder folgen zugleich einem regionalen asiatischen Ansatz in der Ausbildung zur Standardisierung. In anderen Ländern, hier insbesondere in der Europäischen Union, existieren hingegen kaum mehr als die Angebote zur Weiterbildung der jeweiligen nationalen Normungsorganisationen, wobei die Standardisierung insbesondere in der universitären Ausbildung oft keine oder nur eine unbedeutende Rolle spielt. Den Vertretern der Europäischen Union ist die Bedeutung der Ausbildung zur Standardisierung zwar bewusst; mit einem einheitlichen, von der EU geförderten Ansatz in diesem Bereich ist nach einer Reihe von Konsultationen und Workshops zu diesem Thema allerdings nicht zu rechnen.
Eine überwiegende Mehrheit der Experten hält indes in allen Bereichen eine Verbesserung der Ausbildung zur Standardisierung für dringend geboten, da die Standardisierung eine zentrale technische wie sozioökonomische Rolle in der modernen Industrie- bzw. Informationsgesellschaft spielt. Gerade in technologisch fortschrittlichen Bereichen mit hohem wirtschaftlichen Wachstumspotential besteht ein permanenter Bedarf an qualitativ hochwertigen Standards bzw. exzellenter Qualifikation. Eine breite Qualifikation, d.h. Expertise fußt im Wesentlichen auf einem entsprechenden Ausbildungskonzept. Ohne eine zukunftsorientierte Strategie in der Ausbildung zur Standardisierung, die den Bedarf aufnimmt - sind die Folgen entsprechende verpasste Wachstumschancen oder strukturelle Brüche auf technischer und gesellschaftlicher Ebene. Wir fühlen uns insbesondere durch die Entwicklungen im asiatischen Raum in unserem multi- bzw. interdisziplinären Ansatz bestätigt und hoffen, mit diesem Curriculum einen Beitrag zu leisten, der Standardisierung in der Ausbildung zu einem höheren Stellenwert zu verhelfen. Wir wünschen dem Leser viel Spaß bei der Lektüre dieser dritten Auflage, die um vier neue Lernmodule ergänzt und zum Teil umfassend überarbeitet wurde.

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General Introduction to the Curriculum for Standardisation in Companies and Markets

Wilfried Hesser • Axel Czaya • Wenke Siedersleben

1 Standardisation in science and research

Scientific method, namely thinking and acting in accordance with scientific principles, acquiring scientific results and implementing them in various subsectors of society, has experienced a considerable upswing in the last two centuries. This development has been accompanied by the emergence of various scientific disciplines within which refinement of the theories and models has enabled considerable specialisation and an enormous increase in knowledge to take place.
However, the pronounced specialisation in practically all scientific disciplines also has disadvantages and often acts as a barrier between subject areas. This situation makes interdisciplinary exchange difficult and not only leads to alienation but sometimes also to hostility between the disciplines.
This development deserves special criticism in view of the fact that the implementation of scientific findings, e.g. through the development and marketing of new products, affects all areas of business because of the complex causal relationships of dependence in the modern industrial and information society. In order to adequately assess the multidimensional social consequences of implementing scientific findings, it is necessary to overcome the interdisciplinary barriers in and between the various disciplines and return to an integrated view of matters. And, as is our view, standardisation research and education, both cutting across various scientific disciplines, are especially well-suited for such a reintegration effort.

Academic involvement with standardisation as part of a general course of study is well suited for improving awareness of the interdependence between different scientific disciplines, for promoting interdisciplinary collaboration but also for researchers to gain a fresh view of their own academic disciplines. Due to its cross-sectional nature, an examination of standards opens up a view of different subject areas, their methods and objects of investigation. This leads to improved mutual understanding among the representatives of different disciplines, opens up opportunities for interdisciplinary cooperation and thus directly refreshes the way that academics look at their own subject areas and objects of study.

In view of these conditions, and given the fundamental technological and socioeconomic role of standardisation in modern society, it is not surprising that it has moved into the focus of a wide range of academic disciplines. The engineering sciences, for example, began their involvement with standards at a time when they were still of no relevance to other scientific disciplines. Towards the end of the 19th century, it was primarily engineers who dominated the beginnings of systematic standardisation beyond the company level. Consequently, the organisations that operate internationally today, such as the International Electrotechnical Commission (IEC) and the International Organization for Standardisation (ISO), date back to the efforts of engineers to create uniform standards throughout the world.

Engineering standards have a fundamental technical and systemic significance in the modern industrial and information society. If there were no company standardisation, and hence no reduction of variety with a view towards unifying products, components and production processes, the industrial revolution would have been inconceivable. Similarly, technical compatibility standards form an indispensable basis for the computer revolution and the transition from the industrial to the information society. International standards, as developed by international standards bodies, provide an important contribution to the globalisation of economic relations.
The technical and systemic status of standardisation enables direct conclusions to be drawn on its economic importance. For instance, company standardisation and the rationalisation process associated with it enabled low-cost industrial mass production to take place in the middle of the last century and hence made the accompanying economic growth in industrialised countries possible.

The modern science of business management has rediscovered standardisation as a topic only recently. During the last century business management (at least in some of its branches) took a turn towards sociology and psychology or focused on business aspects where standardisation is (seemingly) irrelevant or even detrimental to business success. In the process-oriented management sciences, for example, individual processes are regarded as a decisive competitive factor for an enterprise, and any form of process standardisation runs the risk of disclosing a company's core area of competence and throwing away its competitive advantage. However, advances in information & communication technologies (ICT), the advent of the networked society and the associated business opportunities highlighted the strategic and structural relevance of the underlying standards and have put standardisation firmly back on the agenda of business management scholars. Furthermore, in the context of complexity management, the "old-fashioned" instruments of company standardisation (which many textbooks mention only in passing as part of a historical account of "scientific management", particularly of Taylorism) have made a remarkable comeback in manufacturing as powerful instruments of complexity reduction and rationalisation.

In the economic sciences, an interest in standards has only existed since the middle of the 1980s and was largely inspired by significant advancements in the pioneering field of computer, information and communications technology. Along with these advancements, new and highly profitable markets emerged on which standardisation played (and continues to play) a strategic key role. Economists observed that, for example, so-called de-facto standards were able to dominate an entire market (example: Microsoft's operating systems). Since the middle of the 1980s, a wealth of contributions on the most diverse aspects of standards and standardisation has led to a better understanding of their effects, especially with regard to network effects and de facto standardisation in the market sphere. Many of these contributions focused their attention on standardising the compatibility between products, systems or services. The academic debate today concentrates mainly on standards and their implications for competitive policy, international trade and company strategies.
In jurisprudence, too, standards have become a topic of teaching and research. A large number of laws refer to the "state of the art" or "the generally acknowledged rules of technology". Furthermore, explicit reference may also be made to standards within laws. Issues of product liability where non-compliance to standards can be demonstrated are of particular relevance for companies. Standards play a prominent role as regulatory instruments, especially with regard to market integration. One example of this is the European Union's "New Approach" which aims at the harmonisation of the European single market and is largely hailed as a success story. Under the New Approach, "essential requirements" specify basic demands in the fields of consumer and environmental protection and industrial safety for products that are allowed to be offered for sale in the EU. These essential requirements provide direct input for the design of technical and European standards that are prepared by European standards bodies. Adherence to these standards allows a product to be freely marketed in the European Economic Area.
Obviously, standardisation not only plays a fundamental role in virtually all fields of modern society but also bears significant strategic and regulatory implications. If there is, for example, a chance of enforcing de facto standards on markets, e.g. in the advanced technology industries, companies use a range of different strategic instruments to establish their own standards. The inherent tendency to form monopolies in markets with de-facto standards also presents new requirements for the law on competition and the authorities supervising this law. As standards for companies are increasingly gaining in importance, both during the course of in-company standardisation and as instruments of market strategy, issues of standardisation not only occupy a fixed position in the economy but also in business literature.

The previous comments make it clear that "standardisation" as an object of study is relevant to the content of a considerable spectrum of disciplines in the technical field and social sciences, and in this respect an interdisciplinary approach is justified.

Furthermore, standardisation as an object of investigation does in fact support interdisciplinary work because this demands a basic structure of uniform terminology and suitable communication standards, without which meaningful communication between the disciplines would not be possible at all. To this extent the topic of "standardisation" is a "medium" of interdisciplinary cooperation.

2 The European and Asian dimensions

Even though standardisation is playing an increasingly important role in the global economy, its significance as such, its socio-economic impact on modern societies, regional integration and globalisation is still underestimated in some academic and industrial communities. Over the last few decades standardisation has emerged from being an instrument of rationalisation within companies to become a strategically relevant instrument for entering and occupying globalised markets. Furthermore, if the strategic dimension of standardisation is not taken into account and properly addressed, it can be a technical barrier to trade for companies and countries alike. In other words, full awareness and a sound understanding of standardisation approaches on all sides is a prerequisite for free and international trade, and in particular for Asian-European trade. Moreover, compared to their European counterparts, Asian companies and governmental bodies need to profit more from a knowledge of general features about the European standardisation regime and its specific requirements. The EU actively promotes standardisation and supports non-European countries in becoming familiar with the European standardisation system. The New Approach and the Global Approach, both of which form the core elements of the European standardisation regime, impose specific demands on European and non-European companies who wish to offer goods on the European market. Products that fall within the scope of the New Approach are subject to certification (which is ruled by the Global Approach) and have to comply with European Standards and their underlying EU directives. Furthermore, enterprises operating on the Single European Market need sufficient general information and knowledge about the basic features of the European standardisation approach, as well as specific information on the directives and European standards with which their products have to comply. Although European-Asian co-operation in the field of standardisation does currently exist, it is rather fragmented and rarely found at the academic level. This project will promote the European standardisation system by developing a curriculum for "Standardisation in Companies and Markets", which will incorporate special requirements for Asian countries by setting up the following structures:

- A professional and academic network in standardisation
- A curriculum for "Standardisation in Companies and Markets"
- Teaching materials and an online curriculum via an open-source e-learning platform.

3 The subject of standardisation in higher education

Viewed in a historical context, teaching in the subject of standardisation has been essentially characterised by national industrial development in the first stage and the internationalisation of markets in the second. The change in industrial standardisation and standardisation work can be clearly illustrated by manuals on company standardisation dating from the years 1916, 1930, 1955 and 1975.
In the early days of industrialisation the efforts of national and company standardisation were directed towards the interchangeability of parts and the development of safety standards in electrical engineering, whereas rationalising in the field of production became the focus of standardisation as industrialisation progressed. Up into the 1970s standardisation was primarily used as:

- an instrument of rationalisation
- a method of systematically designing products
- an instrument for organising production, including materials management and control.

In the 80s, with the implementation of computer-aided design (CAD) systems and computer-integrated manufacturing (CIM) concepts, industrial information technology/processing assumed a key function in industry, and with it the exchange of product-specific data beyond the departmental and divisional boundaries.

As mentioned before, scholars of various disciplines discovered standardisation as a research topic in the 1980s, but any systematic teaching in standardisation was – a few exceptions like the Department of Standardisation and Technical Drawing/CAD at the Helmut Schmidt University Hamburg and the Chair on Standardisation at the Erasmus University Rotterdam aside – either non-existent or performed in a fairly arbitrary, lacklustre fashion. In recent years, however, things have changed considerably: influential standardisation experts have put the need for education in standardisation high on the agenda and have started initiatives such as the International Cooperation on Education in Standardisation (ICES) which aim to establish standardisation as a subject of study in higher education on the international level. Some significant steps have been made, especially by Asian countries such as Korea and Japan who are presently

at the forefront of standards education. Korea for instance has devised an all-encompassing top-down approach to standards education which is laid down in "Five-year National Standards Master Plans" (of 2001 and 2006) aimed at creating an advanced standardisation system and building up adequate standards expertise and manpower.

Indeed, we strongly endorse these initiatives to which this book is no more than a contribution. Our recent research in cooperation with Tineke Egyedi of Delft University of Technology has shown that standardisation is increasingly becoming a subject of study in higher education within Europe. This trend is most welcome, of course, but an overarching European approach to standardisation education still does not exist and, in this respect, Europe significantly lags behind the Asian region. In accordance with many European standardisation experts, we therefore not only ask for the introduction of a coherent European approach to standardisation education, but also for the utilisation of the most advanced educational tools available. The teaching of standardisation has to adopt a future-oriented approach and take into account the following trends: developed, industrialised societies currently find themselves in a phase of transition from an industrial society to one based on knowledge. Nowadays, information has become the most important "raw material" and the decisive performance factor. Countries with competitive advantages are those that achieve success in the creation and distribution of information, in the efficient conversion of this information into knowledge, and particularly in the broad-based exploitation of this knowledge.
A society based on information and knowledge will both demand and facilitate new forms of teaching and learning. Institutions of higher education, i.e. their teaching staff, professors and curricula, have a formative influence on the views, motivation and performance of future managers in industry and commerce.
We wish to turn away from the traditional forms of disseminating knowledge in standardisation teaching and move towards the use of web-based training in the sense of integrating different information and communications technologies in order to convey the knowledge and structure for the learning process. With the aid of multimedia technology, it is not only possible to devise new didactic concepts for target-oriented and interdisciplinary learning, but also to open up new opportunities for organising and exploiting teaching material and for synergies and new (forms of) cooperation and networking among students and scholars.

One important feature of this concept is that this knowledge of standardisation is available for study all the time and everywhere on a global basis, i.e. for a knowledge-based society as such, as well as for both industrialised and newly industrialising nations and also for countries in transition.

4 The curriculum on standardisation and e-learning

E-learning is a learning method that meets the specific requirements of students through modern information and communication technology. With the rapid expansion of the Internet, e-learning has become an increasingly important tool for disseminating knowledge and education. Thanks to e-learning technologies, high-quality teaching and training resources can be accessed form anywhere and at any time.
A variety of course materials – text, graphics, maps, and audiovisual tools - can be offered through e-learning. In addition, e-learning includes interactive features such as exercises, threaded discussions, and chat rooms. E-learning is most effective in combination with classroom activities, combining the advantages of modern technology and traditional teaching.
With the aid of multimedia, a teaching service of this nature can be extended to include greater range and new quality both from the student's own university and from external universities, thus increasing the depth of material or broadening the scope of material offered within a faculty or even in order to facilitate self-study through the support of media. For standardisation as a subject of study this will present an opportunity for integration into a wide variety of other subjects at national, European and international higher education establishments. Standardisation will be offered as a subject of study at college and university faculties using an approach based on e-learning.
Cooperation and networking between institutions of higher education on the basis of multimedia may give rise to new opportunities for redefining subject priorities in teaching and study and for altering an institution's profile. This development will allow students in particular to use the curriculum of other higher education institutions during their studies and thus take advantage of these extended options for determining personal specialisations within their own specific course of education. Against this background, we do indeed regard multimedia as a challenge but then again as a great opportunity for the subject of standardisation to become an option in a wide range of courses due its ability to be included as a multimedia module. The standardisation curriculum may

- form parts of a structured degree course, or
- be an optional subject to complement and provide more detail in a particular subject specialisation.

This e-curriculum – *Standardisation in Companies and Markets* – will target students on various existing master's programmes. The e-learning project will deliver an academic, modular and multidisciplinary curriculum. The target groups were identified as belonging to the following faculties/departments: economics, business administration and engineering.
The curriculum will enable those universities to offer high-level academic courses on various aspects of European standardisation leading to the attainment of an academic qualification in the field of (European) standardisation.

The curriculum is distributed via the open-source e-learning platform already implemented at www.pro-norm.de.

The underlying aim of the teaching concept is to provide an interdisciplinary interpretation. During their studies, students of mechanical engineering and industrial engineering should gain an understanding of the relations between the various parts of the production and economic processes that are affected by technical standardisation. A further aim is to generate an awareness of standardisation against the real background of an industrialised society, by illustrating how strongly standards influence individual areas of life and work.

The curriculum consists of 26 teaching and study units and covers the current problem areas of standardisation as well as several case studies. Each teaching and study unit offers educational added value. Multiple choice tests, frequently asked questions, exercises and glossaries have been developed and formulated to support every study unit. The didactic concept is a blended learning approach, in other words a combination of media-based/online and campus-based phases. Internet as a medium is used to supplement rather than substitute.

Linking Internet and computer based teaching will give rise to new opportunities for directly integrating current approaches and research results. In this way the unity of research and teaching will be intensified by a scheme of study oriented towards theory and best practice. The curriculum – *Standardisation in Companies and Markets* – together with this textbook will strive to cover defined skills leading to recognised key qualifications for students, offered either as a preparatory measure or enabling them for a particular profession.

5 The book and its contributions: theory and practice united

Originally, this curriculum profile, its structure and content areas were drawn up jointly by the project partners during the first and second workshops in Hanoi and Hamburg in the year 2004. It was made up of 22 units of which 19 were published in the 1st and 2nd editions of this book. This 3rd edition, however, is supplemented with four additional contributions. Firstly, we are glad to have recruited three renowned experts in standardisation affairs to contribute to the 3rd edition, namely Tineke Egyedi (Delft University of Technology), Richard Hawkins (University of Calgary) and Kai Jakobs (RWTH Aachen University). Tineke and Richard deal with standards consortia (Unit 10), while Kai addresses ICT standardisation (Unit 11) - two issues which had not been given due attention in the preceding editions of the book. Secondly, Nicole Riemer draws on the thesis she wrote at the Department of Standardisation and

Technical Drawing/CAD and outlines the challenges that formal standardisation is presently encountering (Unit 12), and thirdly, we have added a unit on standardisation strategies of firms which supplements the existing units on the strategic dimension of standardisation (Unit 8). We are deeply indebted to Nicole, Tineke, Richard and Kai for their involvement and their contributions to this 3rd edition of "Standardisation in Companies and Markets".

Basically, these 23 units form three sections:
1. Introduction to standardisation (Units 1 to 4)
2. Theoretical aspects of standardisation (Units 5 to 18)
3. Practical aspects and examples of standardisation (Units 19 to 23)

The individual units are as follows:

01	Fundamentals of Standards and Standardisation
02	An Introduction – The History of Standardisation
03	Economic Aspects of Standardisation
04	Development of Standards
05	Standardization in Product Development and Design
06	Standardization within a Company – a Strategic Perspective
07	External Standardisation as a Company Strategy
08	Standardisation Strategies of firms
09	Standardisation and Innovation
10	Standards Consortia
11	ICT Standardisation
12	Challenges and Approaches of Efficient Formal Standardisation
13	International Standardisation
14	Standardisation and International Law
15	The European Standardisation Regulatory Framework
16	The Standardization Policy of the European Union
17	Standardisation and Law in the Federal Republic of Germany
18	The European Union and its New Approach
19	Conformity Assessment
20	Metrological Management
21	Quality Management Methods and ISO 9000 Quality
22	Implementation of the ISO 14000 Environmental Management System
23	Agricultural Standardization

Units 1 to 4 serve as an introduction to the subject matter and provide the reader with an overview of the many different aspects of standardisation. Unit 1 (Fundamentals...) is a review article, which in itself touches on all facets of standardisation. Unit 2 (History...) explains a number of historical aspects of standardisation and informs the reader about the latest developments in the academic debate on standardisation. Unit 3 (Economic Aspects...) examines the economic importance of standardisation, which ultimately represents the driving force of many - if not all - standardisation activities. Unit 4 (Development of Standards) already marks the transition to the theoretical section and discusses various ways of preparing standards and describes the possible behaviour of the different actors involved in standardisation processes.

The section on the theoretical aspects of standardisation is the largest of the three and covers a spectrum ranging from the methods of standardisation in design (Unit 5, Product Development and Design) and the instruments of standardisation inside a company (Unit 6), via the organisation of international standardisation (Unit 14) through to aspects of European standardisation policy (Unit 18, New Approach). Unit 7 (External Standardisation...) discusses strategies that a company can employ to succeed in various standardisation processes. Unit 8 addresses additional strategic issues, whereas Unit 9 (Standardisation and Innovation) deals with the decidedly multifaceted relationship between standardisation and innovation, and Units 10 and 11 – as already indicated – discuss standards consortia and ICT standardisation while Unit 12 is devoted to the challenges that formal standardisation faces. Unit 13 outlines the organisation of international standardisation and is complemented by Unit 14 which illustrates the connection between standardisation and international law, which is of great interest for companies with international operations. Units 15 and 16 form a single entity and deal not only with the legal but also the political aspects of the European standardisation approach. A sound understanding of the organisation of European standardisation is of great importance for any company that is active on the European market. To conclude the section on theoretical aspects of standardisation, Unit 17 (Standardisation and Law in the Federal Republic of Germany) again investigates the legal aspects of standardisation, but this time on a national level, and Unit 18 (New Approach) discusses the currently valid standardisation regime of the EU.

Unit 19 looks at the very important aspect of conformity assessment. These issues are of great practical relevance for companies that wish to become involved in certain markets. The same applies to the aspect of metrology (Unit 20), which represents an important sub-element of conformity assessment. To round off the curriculum, Units 21 to 23 provide examples of successful and widespread standards together with the opportunities that arise for companies if they implement these standards. Unit 21 examines the prominent ISO 9000 series on quality assurance, while Unit 22 deals with the no less familiar ISO 14000 family of environmental standards. As a conclusion to the curriculum, Unit 23 looks at standardisation in the field of agriculture.

6 Outlook and vision

The previous statements make it clear that standards play a fundamental technological and socioeconomic role in modern society and represent an interesting object of teaching and research not only in the sciences of engineering sciences, economics, business management and jurisprudence, but also in the humanities and the social sciences, and that an interdisciplinary approach is essential. Our basic goals are in line with those of many prominent initiatives within the standardisation community, i.e. to establish standardisation not only as a subject of study in education but also as an acknowledged scientific discipline in its own right. Another aim is to show that standardisation is not the boring issue many scholars and students consider it to be, but a multifaceted and interesting topic that opens up a new and fresh perspective on other objects of research or fields of study. Furthermore, standardisation as a topic that cuts across a large range of scientific disciplines is ideally suited to (re-)introduce elements of a "studium generale" whenever a more holistic approach is to be taken or the trend towards specialisation and fragmentation in science is to be counteracted.

It is particularly the most advanced and dynamic fields such as ICT where standards preparation is becoming increasingly complex and depends crucially on the expertise of those agents involved in standards design, and this expertise in turn depends on sound standardisation education. Without adequate standardisation education there would not be sufficient standardisation expertise, resulting in a qualitatively as well as quantitatively inadequate supply of standards and the consequent detrimental effects on society and welfare, namely insufficient networks and infrastructures, impaired technical progress and innovation dissemination, missed business and market opportunities, impaired competitiveness and forfeited growth potential. Hence, standardisation education is not merely something "nice to have" but an absolute must in order to master the challenges that lie ahead. But as stated before: standardisation can also be fun – and this is what we hope the reader is going to have with the 3rd edition of our book.

Henk de Vries

Abstract

This lecture provides an introduction to standards and standardization. In Chapter 1 we introduce the phenomenon, provide a short historical overview, tell about the use of standards and give reasons for the growing importance of standards. In Chapter 2 we define standards and describe different categories of standards. In Chapter 3 we will talk about standards development. Once a standard is available, it is not self-evident that companies and other organizations will apply it. Moreover, they may have the choice between different standards. In Chapter 4, therefore, we will discuss the acceptance of standards. After a company or other organization has accepted a standard, the organization has to implement it. This topic is addressed in Chapter 5. Once implemented, the standard has impact: for the company and for other stakeholders. We will describe this in Chapter 6.

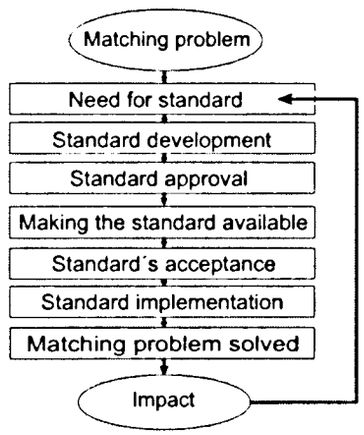


Figure: Standardization model (© de Vries)

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1 Preface

Standards are very common in every-day life. The A4 series of paper sizes, the fitting of light bulbs into sockets, ISO 9000 requirements for quality management systems,the use of the metre for distance measurements, McDonald's product and service specifications, and the specifications of the GSM mobile phone system all have one thing in common: the fact that they are used repeatedly by a large number of people and, therefore, are laid down in standards. We can distinguish between standards and the process of developing them: standardization. The A4 series was developed by the German national standards body DIN and published in 1922. The ISO 9000 standards come from ISO: the International Organization for Standardization. Their predecessors were military standards from the NATO. McDonald's standards are examples of company standards, developed within the company of McDonald's itself. The GSM specifications were developed by a consortium of companies and have been laid down in standards of the European Telecommunication Standards Institute (ETSI). The activity of making standards may be called standardization.

1.1 Short historic overview

Even in ancient times, several cultures had already developed standards for weights and measurements, e.g., 3200-2800 BC in Mesopotamia (Ritter, 1996). These standards facilitated trade. Often, the dimensional standards were taken from the human anatomy, frequently the king's body, e.g., the 'cubit' was the distance from the elbow to the wrist and varied from 0.444 metres (Palestinian cubit) to 0.641 metres (Roman cubit) (Spivak & Brenner, 2001, p. 7).
Kings could enforce the application of such standards. Ancient China provides an example of political reasons for standardization. The first emperor of China, Qin Shi Huangdi, who died in the year 210 BC, united the various states of the Han Chinese to form a single empire. He used standards to reinforce this unity, to encourage trade and movement and to promote prosperity. Examples included technical standards on weights and measures, on water conduits and road construction, and on the axle and wheel bases of transport vehicles, which, in turn, led to standards for the width of town gates (Ellias, 1999).
During the Middle Ages in Europe, guilds developed their own professional standards, often at a local level. The ancient Chinese standards served military purposes as well. In the 15th century, the Republic of Venice (in the North of what nowadays is called Italy) equipped its warships with standardized rudders, masts, sails, etc., and standardized spare parts were kept available for the fleet in depots located in various ports (DIN, 1991).

Two centuries later, technological progress made it possible to achieve a better quality of muskets. In 1798 in the USA, Eli Whitney standardized parts for muskets to enable the production of 10,000 muskets in two years by assembling them from standard parts. This can be seen in the first 'modern' example of the application of standardization in mass production (Kuppanna, 1988, p. 2, Verman, 1973, p. 8). Standardization emerged properly during the industrial revolution (Brady, 1929, Chapter 1). In many branches of industry, individual companies started to develop their own company standards but, because of similarities in needs, they started to cooperate with other companies and then standards for each business sector were developed, e.g. building (ASTM Standardization News, 1998) and textiles (Pratt, 1998). In some cases, scientists were initiators, e.g. in the development of a coherent systems of units (Teichmann, 2001) and in the area of statistics (Stigler, 1996). Subsequently, industrialists and engineers from different fields joined forces at the national level, first in Great Britain (McWilliam, 2001). In electrotechnology and telecommunications, standardization started both earlier and at the international level from the outset, in other branches of industry the national level came first (Simons and De Vries, 2002, Chapter 2).
Political reasons in Europe have led to standardization emerging at a regional level since 1959; nowadays other regions have taken similar initiatives as well.

Other trends in standardization include:
- less use of company standards, more use of external (as seen from a company's point of view) standards;
- within the collection of external standards: a shift from national standards to global and (in Europe) regional standards;
- increase in use of standards developed by industrial consortia, especially in the field of information and communications technology;
- shift from merely industrial markets to include service sectors as well;
- in (former) state economies: shift from governmental standardization to private standardization, in other countries the opposite: increasing governmental involvement in standardization, with interrelations between legislation and standards.

You can find more on the history of standardization in Chapter 2, several items given a brief mention here will be dealt with in more detail in other units.

1.2 Use of standards

Standards can be used by companies, but also by other groups in society, such as governments and testing organizations. We distinguish between *direct users* or *implementers*: parties that read the standard to apply it, and *indirect users*: parties that have a stake in the application of the standard. A party can be a person, a group of people or an organization.

1.2.1 Direct users or implementers

In general, the category of direct users includes:
- Designers: parties that devise products, services and processes in order to make a design that meets criteria laid down in a standard;
- Testers: parties that test products, services or processes against the requirements in a standard or that use a test method specified in a standard;
- Advisors: parties that provide advice concerning designing or testing according to a standard;
- Regulators: parties that develop regulations, other requirements, standards, rules or laws based on a standard.

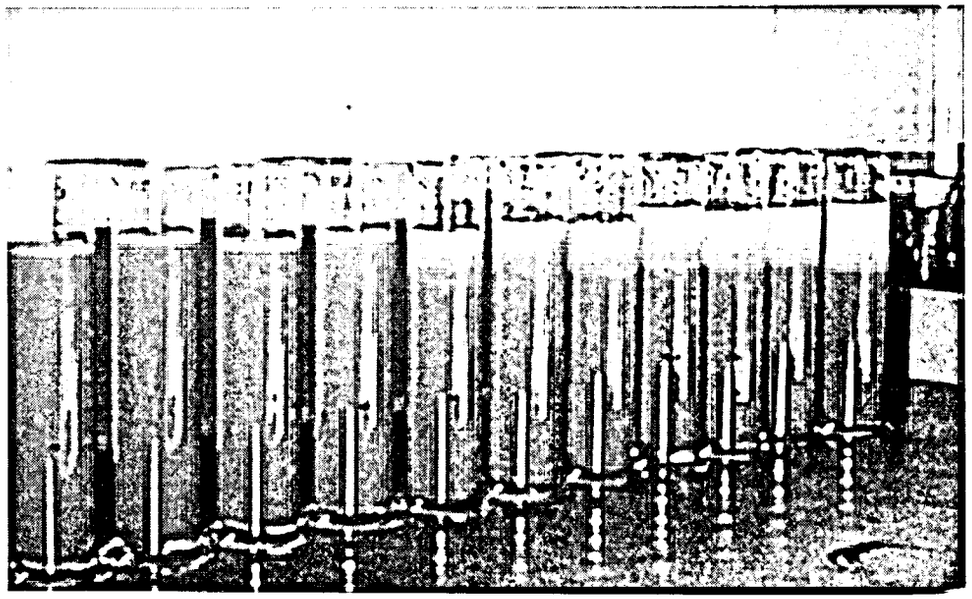


Figure: Soil test method (www.dlwc.nsw.gov.au)

The activities of these direct users of standards are carried out by, or for, organizations like companies, testing laboratories, certification bodies, consultancy firms and governmental agencies. Standardization can be very important for these organizations: standards may apply to or can be developed for the products or services delivered or purchased by these organizations, or may apply to the business processes in these organizations

1.2.2 Indirect users

Indirect users of a standard are primarily consumers or professional users of the product, service or process for which this standard is used (Krechmer, 2006). These users normally do not read standards, but, nevertheless, the results of applying standards in the product, services and processes are important for these groups. Other indirect users can be special interest groups, such as branches of business organizations (for the common interests of their members), trade unions (for the interests of workers), and environmental pressure groups. The main users of standards are companies, governments and consumers.

1.3 Growing importance of standards

The importance of standards is growing, because (De Vries 1999):

- Companies, in general, can no longer be regarded as isolated organizations, not only in trade transactions but also in their technical operations. Especially in the area of information and communications technology (ICT), companies are connected to other companies. In other areas, too, technical specifications chosen by the company have to fit specifications of the company's environment. For example, ICT without standardization is impossible, and the chemical composition of petrol should not vary from country to country.

- The tendency to concentrate on core business and to contract out other activities makes it necessary to agree with suppliers on, for instance, product specifications, product data, communication protocols, and the quality of the production and delivery processes. Because the company usually has several suppliers, each with several customers, the most profitable way to solve these problems of matching is by using widely accepted standards.

- There is a tendency to pay more attention to quality and environmental issues in a systematic way. This has increased the need for management system standards, such as the ISO 9000 series of standards for quality management and the ISO 14000 series for environmental management. It has also increased the need for other standards, because management systems cause companies

to perform activities in a structured way; standards for products, the means of production and information systems contribute to the required structure.

- Globalization of trade increases the need for international standardization.

- Within the European Union and the European Free Trade Association, the choice for one single market without barriers to trade is causing replacement of differing national standards by European equivalents. This makes export for companies that trade with a number of countries easier. There is no longer a need to produce different versions of one product to meet different standards in different countries. However, companies that mainly serve national markets, especially in smaller countries, have been confronted with a substantial increase in the number of standards that are used.

- There is an increasing need to provide confidence to customers and other stakeholders, which can be partly achieved through certification. Certification is a procedure by which a third party gives written assurance that a product, process or service conforms to specified requirements (ISO/IEC, 2004). In general, these requirements are laid down in standards.

- Both at the European and the national level there is a general tendency to link standards to legislation, in such a way that standards provide detailed requirements that correspond to the global requirements laid down in laws. This causes an increase in the number of standards and an increase in obligations to use them.

2 Standards

The term standard has been defined at the international level (ISO/IEC, 2004): a document, established by consensus and approved by a recognized body, that provides, for common and repeated use, rules, guidelines or characteristics for activities or their results, aimed at the achievement of the optimum degree of order in a given context. Unfortunately, not all of the above examples fit in this definition: not all standards are consensus-based or approved by a recognized body and standards may have a format other than a document, e.g. software as in the case of Windows. Therefore, De Vries (1997) has developed another definition: a standard is an approved specification of a limited set of solutions to actual or potential matching problems, prepared for the benefits of the party or parties involved, balancing their needs, and intended and expected to be used repeatedly or continuously, during a certain period, by a substantial number of the parties for whom they are meant.

Properties of a good standard (Simons and De Vries, 2002, pp. 13-15):
1. Provides a solution for a matching problem,
2. Fulfils the need of parties (workable and acceptable),
3. More than one involved party,
4. Lifetime longer than the process for creating the standard,
5. Not in contradiction with other valid, operational standards,
6. Backwards compatibility,
7. Does not block a-priori future improvements/developments,
8. Easily readable and unambiguous,
9. Fit for repetitive, frequent application.

2.1 Standards categories

In this section we will mention some categories of standards. A more systematic and complete approach to this topic has been presented by De Vries (1998 and 2006). A distinction can be made between basic standards, requiring standards, and measurement standards. Basic standards provide a structured description of (aspects of) interrelated entities. Requiring standards set requirements for entities or relations between entities. Measurement standards provide methods to be used to check whether requiring standards' criteria have been met.
Requiring standards can be divided into performance standards and standards that describe solutions. The Agreement on Government Procurement (resulting from the Uruguay Round along with the World Trade Organization) advocates performance standards rather than standards that describe solutions (Schwamm, 1997, pp. 17-18). Companies and other stakeholders in standardization in general share this policy because standards that describe a solution may hinder innovation. Most developing countries, however, prefer descriptive standards with a large number of technical details (Hesser & Inklaar, 1997, p. 38). One reason for this may be that it is easier to understand and implement the standard when it describes a solution in detail. The percentage of performance standards is growing, at the expense of standards that prescribe certain solutions.
Another possible subdivision of requiring standards concerns the distinction between (De Vries, 1998): interference standards, compatibility standards and quality standards. Interference standards set requirements concerning the influence of an entity on other entities. Compatibility standards concern the fitting of interrelated entities to one other, in order to enable them to function together. Quality standards set requirements for entity characteristics to assure a certain level of quality. Compatibility standards are always descriptive; interference and quality standards can be performance standards as well as solution-describing standards. In fact, measurement standards are a parti cular kind of requiring standards, namely, standards that describe a solution for measuring.

2.2 Standards and Intellectual Property Rights

Aggarwal and Walden (2005) conceptualize IT standards as bundles of patents. Though this is exaggerated, it is a fact that many standards lay down requirements for which patents apply (Clarke, 2004). A licensed standard is created when a company (or group of companies or agencies) establishes a new design, gains patent or copyright protection for it and explicitly sets out to persuade other companies to use this same design (Crawford, 1991, p. 44). Standards and patents both describe a largely technical solution. A standard, however, is intended to be used by all parties for which it is meant, whereas a patent is only used by the patent-holder and by third parties who have been granted licences by the patent-holder and who usually have to pay for this use.
What standards and patents have in common is the fact that they provide information to prevent the wheel from being reinvented.

3 Standards development

3.1 Company standards

By the end of 2003, the People's Republic of China had 20,226 national standards (including adopted international standards), more than 32,000 professional standards, more than 11,000 local standards and more than 860,000 company standards (Wen, 2004). Most other countries do not have a central registration of company standards, but it is reasonable to expect that in other parts of the world, too, the number of company standards will outweigh the number of other standards to a similarly large extent. A company standard is the result of standardization by a company or other organization for its own needs (Düsterbeck et al. 1995, p. 107). Company standardization includes developing standards for use within the company and developing standards to be used in the company's relations with its direct business partners (De Vries, 1999, p. 231). 'Developing' does not mean that each company standard has to be designed from scratch.

A company standard may have the form of (ibid.):
- a reference to one or more external standards officially adopted by the company;
- a company modification of an external standard;
- a subset of an external standard (for instance, a description of the company's choice of competing possibilities offered in an external standard, or a subset of the topics covered in the external standard);

- a standard reproduced from (parts of) other external documents, for instance, suppliers' documents;
- a self-written standard.

Companies may prefer external standards, for example international standards, but these do not always meet all their needs and, therefore, they complement such external standards with all the forms of company standards just mentioned. In most companies, the number of company standards exceeds the number of external standards.

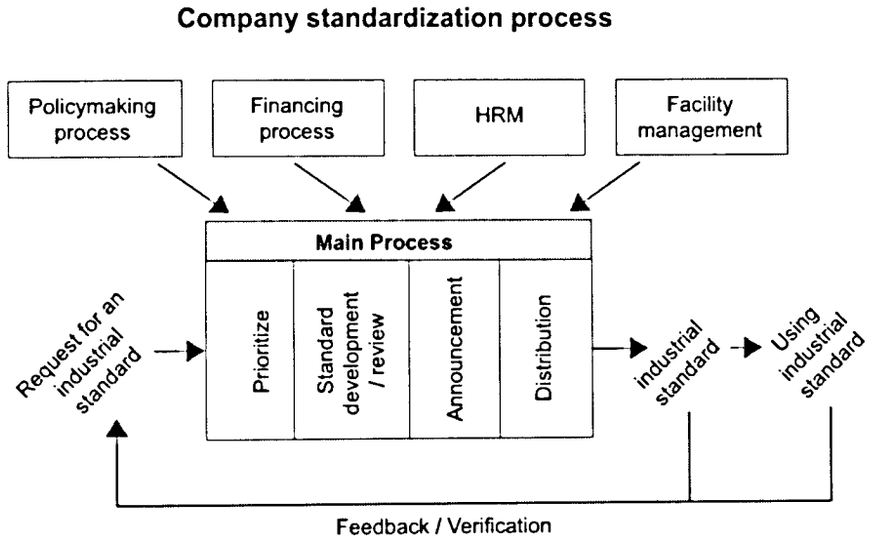


Figure: Company standardisation processes (© de Vries)

3.2 Choice between company standardization and co-operation

When a company needs a standard that is not yet available, it has a choice between developing its own company standard or cooperating with others to draft a common standard.

Choice between company standardization and co-operation

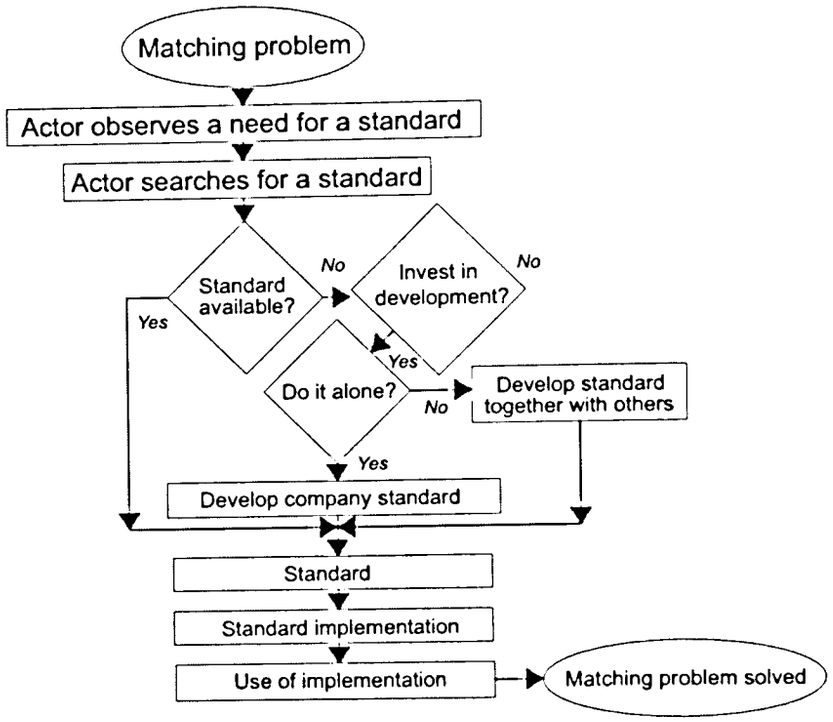


Figure: Choice between company standardization and co-operation. (© de Vries)

3.3 Parties in joint standards development

The main stakeholders in most standardization projects are manufacturers of products and services, the professionals that support the development of these products and services, and the customers that buy the products and services. Other stakeholders include the organizations that represent these stakeholders (e.g. branches of business organizations, professional societies, and consumer organizations), governmental agencies, organizations for testing and certification, consultancy firms, research institutes, universities, and special interest groups, such as trade unions and environmental pressure groups.
Very often,the manufacturers dominate the standardization. Joint standards development can take place in industrial consortia, branches of business organizations, professional associations, governmental agencies or, last but not least, formal standardization organizations. In this introductory unit we focus on formal standardization and give a short introduction to standardization in

consortia. Three levels of formal standardization can be distinguished: national, regional and global.

Formal standardization

	Area		
Level	Telecommunication	Electrotechnology	Other
World	ITU (1856)	IEC (1906)	ISO (1947)
Region (Europe)	ETSI (1988)	CENELEC (1959)	CEN (1961)
Country (Netherlands)	NEN - Nederlands Elektrotechnisch Comité (1911)	NEN - Nederlands Elektrotechnisch Comité (1911)	NEN - Nederlands Normalisatie-instituut (1916)

Figure: Formal standardization (© de Vries)

3.4 National standardization

More than 150 countries have a national standardization organization (NSO). Well-known examples are AFNOR (Association Française de Normalisation, France), ANSI (American National Standards Institute), BSI (British Standards Institution), DIN (Deutsches Institut für Normung, Germany), JISC (Japanese Idustrial Standards Committee), SAC (Standardization Administration of China), and Standards Australia. In North-West and Central Europe and in France, Italy, Australia, the USA and Japan, such organizations were founded in the first decades of the 20th century. Before and shortly after the Second World War, other European countries, several South-American countries, India and South Africa followed. More than 100 other NSOs are less than 30 years old (Toth, 1997). Most of the first and second generation of NSOs were founded by people from industry with the aim of establishing national standards. The NSOs provided the platform for national stakeholders to agree on standards, and published the standards. Most NSOs are private organizations but in many developing countries and former state economies they are part of the governmental administration. Governmental standardization organizations in industrial countries include JISC, NSAI (National Standards Authority of Ireland), and SCC (Standards Council of Canada). Though these are governmental bodies, their activities concern voluntary standardization.
NSOs usually define the following steps for the development of national standards: 1) request, 2) assignment to a committee, 3) drafting, 4) public comment, 5) review of comments, 6) approval, 7) publishing, 8) publicity, 9) implementation, and 10) evaluation. Decision-making is consensus-based.

Possible Structure of a National Standardization Organization

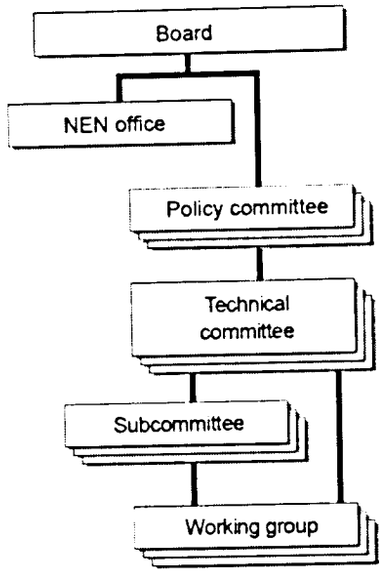


Figure: Possible structure of a National Standardization Organization (© de Vries)

3.5 International standardization - Global

Formal standardization at the global level comprises the International Telecommunication Union (ITU), the International Electrotechnical Commission (IEC) and the International Organization for Standardization (ISO). ISO and IEC have been established by NSOs and, in turn, recognize only one NSO per country. This is an important reason why countries with lots of sectoral standardization organizations, such as Japan, Norway, and the USA, also have an NSO. The NSO has to be an intermediary between national stakeholders and the global and regional standardization arena. ISO and IEC have a hierarchy of committees for standards development and approval. On the 'lowest' level are working groups (WGs), where experts develop standards. A WG develops one or a number of standards and can then be disbanded. Decision making on standards takes place in Technical Committees (TCs). Many TCs have delegated a part of their activities to an in-between level: Subcommittees (SCs). Participants in TCs and SCs are national delegates, whereas NSO committee members represent national stakeholder groups. Delegates are expected to speak and act on behalf of their country, not on behalf of their company or stakeholder group. NSO committees

formulate the national standpoints for voting or for input by participation in committees at the international level. Therefore, NSOs tend to form national Technical Committees, which more or less reflect the committee structure of ISO/IEC. In national standardization, decisions are based on consensus. ISO and IEC use the consensus principle within committees that draft standards, but voting also takes place at several crucial stages of standards development. NSOs vote on behalf of their country.
The main stages in developing an ISO standard can be found on the ISO website.

National contribution to global Standardization

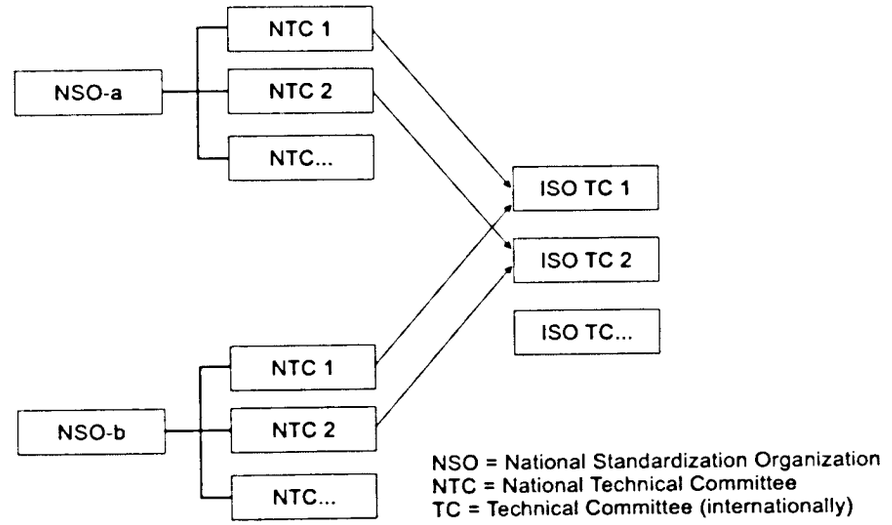


Figure: National contribution in global standardization (© de Vries)

3.6 International standardization - Regional

Region	Standardization organisation
Africa	African Regional Organization for Standardization (ARSO)
Arab countries	Arab Industrial Development and Mining Organization (AIDMO)
Europe	European Committee for Standardization (CEN - Comité Européen de Normalisation) European Committee for Electrotechnical Standardization (CENELEC - Comité Européen de Normalisation Electrotechnique) European Telecommunication Standards Institute (ETSI)
Former Soviet Union	EuroAsien Interstate Council for Standardization, Metrology and Certification (EASC)
South East Asia	ASEAN Consultative Committee on Standards and Quality (ASEAN = Association of South-East Asian Nations)
Pacific	Pacific Area Standards Congress (PASC)
Americas	Pan Americas Standards Commission (COPANT - Comisión Panamericana de Normas Técnicas/Pan American Standards Commission)
North America	Council for Harmonization of Electrotechnical Standards of the Nations of the Americas (CANENA - Conseja de Armonizacion de Normas Electrotecnicas de Naciones de America)
South America	MERCOSUR Standardization Association (MERCOSUR AMN - Mercado Común del Sur (Southern Common Market), Asociación Mercosur de Normalización)

Figure: Regional standardization organizations (© de Vries)

In many regions of the world, special standardization organizations have been established. Most of these organizations do not develop their own standards but provide a forum for discussing standardization matters of common interest. And the list is not complete - other, more informal, forms of cooperation exist, e.g., between the Baltic countries, between Turkey and its neighbouring countries, and between China, Japan and South Korea. In one region there is a huge amount of common standards development, namely Europe. CEN, CENELEC (electro-technical standardization) and ETSI (standardization in the field of telecommunication) have developed thousands of standards. The standards development processes of CEN are almost identical to those of ISO. One main difference is that in ISO each member country has one vote, regardless of its size, whereas CEN operates a system of weighted voting. A second difference is that once a European standard has been adopted, CEN members must implement it by giving it the status of a national standard, either by publication of an identical text or by endorsement, and by withdrawing any

conflicting pre-existing national standards, irrespective of whether or not they agree with the contents of this European standard. In the case of ISO standards, they are free to implement a standard or not. Although it is compulsory to adopt European standards as national standards, this does not imply that use of the standard is obligatory as well - these national standards remain voluntary standards.

3.7 New Approach: European standards related to legislation

In some cases, there is a close relation between standards and legislation. At the European level this applies especially to the so-called New Approach. In the 'Old Approach', member states imposed their own technical specifications and conformity controls for manufactured products. Any technical harmonization across the European Union relied on agreeing directives for individual products. The requirements in these directives then had to be implemented into the legal systems of the member states. European directives set detailed requirements, mainly on product safety. It took many years to agree on the safety requirements and often the directive was outdated by the time it was ready. Therefore, it was decided to replace this by a New Approach in which the directives set only the essential requirements on, for instance, safety, health or environment, and these requirements are formulated globally. Linked to these directives, European standards are developed in which detailed requirements and/or test methods are laid down. A company that meets the relevant standards is assumed to meet the general requirements set in the directives. Thus, implementing the standards is an efficient way to meet the legal requirements. The company, however, is allowed to meet these requirements in another way. Conformity to requirements in the directives is indicated by means of the CE marking (CE = Conformité Européenne), see Leibrock (2002) and Huigen et al. (1997).

The process of CE marking

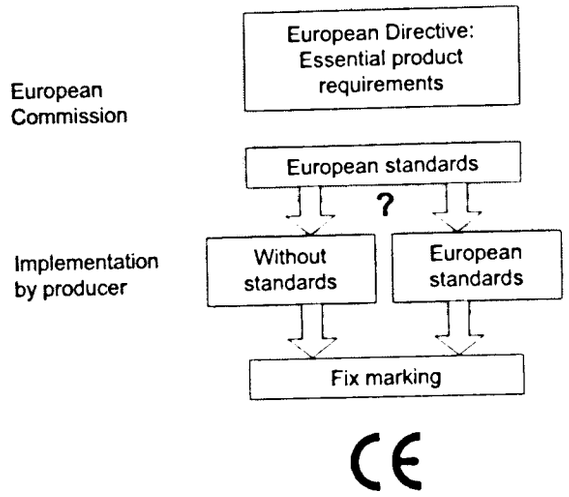


Figure: CE marking (© de Vries)

3.8 Standards development by consortia

Many standards are developed by industrial consortia and their market share in standards development is growing. Sometimes, stakeholders other than companies participate as well.

Reasons for using a consortium instead of a formal standardization organization may be (Simons & De Vries, 2002, p. 51):

- speed: in general, consortia can be faster;
- confidentiality: in cases where the technology is still being developed, the companies that possess the knowledge may dislike the openness of formal standardization. The form of a consortium may allow them to have a non-disclosure agreement;
- intellectual property rights: In general, formal standardization organizations only allow the inclusion of patents in standards when the patent holder declares that he is willing to negotiate licenses under patent and like rights with applicants throughout the world on reasonable terms (Clarke, 2004). For companies that possess essential patents, this requirement may be unattractive. If they expect that high license fees will not hinder market acceptance, they may prefer a consortium that allows such fees.

Sometimes, standards developed by a consortium are offered to a formal standardization organization at a later stage. Reasons for this may include:

- giving the standards additional status;
- making the standards better known;
- ensuring maintenance of the standard: in formal standardization, a Technical Committee is responsible for the standard and has to assess after, for instance, five years whether the standard should be withdrawn, changed or reconfirmed, a consortium may have been dismantled by then.

Standards developed by consortia maybe called consortium standards, to be distinguished from company standards, formal standards, sectoral standards and governmental standards. Many authors use the term de facto standard for standards developed by consortia, and distinguish these from de jure standards. De facto means 'in fact', whereas de jure means 'by right' or 'by a lawful title' (Gove, 1993). Applied to standardization, this would mean that a de jure standard has an official seal of approval by a recognized authority, whereas a de facto standard just happens to be there. However, almost all standards have a form of approval, for instance, from a standards body, a consortium or within a single company. Then the question remains as to whether or not this organization has been recognized in the right way. Until recently, several of the official standards bodies had no governmental recognition at all - they had originated from private initiatives and remained fully private organizations.
Now the national governments have appointed many of them as WTO enquiry points. On the other side, certain consortia may have governmental recognition. Therefore, it is better to avoid the terms de jure and de facto standard and to use formal and consortium standard. Egyedi (2001 and 2003) provides a critical discussion on consortia.

3.9 Anticipatory, concurrent and retrospective standardization

Standardization freezes solutions for matching problems. Depending on the moment these problems are solved, three types of standardization can be distinguished (Stuurman, 1995, p. 27): anticipatory, concurrent and retrospective standardization. In general, standardization combines a design and an approval process. However, in many cases the design is available already and the only thing the standards setting organization has to do is to decide to adopt this document, which may have been developed by, for instance, a company or another standardization organization. In anticipatory standardization, solutions have often not yet been developed. In that case, standardization includes designing solutions. In retrospective standardization, there are often several

solutions, and standardization then selects one or some of these or, if none of the solutions is acceptable for the parties involved, a new solution may be developed. The combination of existing solutions and the modification of existing solutions are in-between options.

4 Standards acceptance

Standards that have been developed have to be made available: on paper or in electronic formats, e.g. on the Internet. Many standardization organizations provide the standards for free on the Internet. This applies, for example, to the standards of the European Telecommunication Standardization Institute ETSI. However, for many standards one has to pay. This applies to national standards in most countries of the world, and to the standards of ISO, IEC, CEN and CENELEC. Several other standards are not available at all, e.g., the criteria Michelin uses to assess the quality of top restaurants, the Coca Cola recipe, and the technical specifications developed by some of the industrial consortia.

4.1 Markets, alliances or hierarchies

In a market economy, most standards are voluntary standards. It is up to the companies and other organizations as to whether or not these organizations use the standards or not. In a central economy, the central administration may force the use of certain standards. However, in market economies as well, some standards are compulsory. For example, many countries prescribe the food safety management standard HACCP. On the other hand, as is also the case in central economies, the choice of whether or not to use certain standards may be left to the company. A third possibility next to 'markets' and 'hierarchy' is that a group of companies or other organizations agree to the use of certain standards. Examples:

- A group of business organizations may agree that in order to be allowed to be or become a member, the companies have to meet certain (quality) standards. For example, in The Netherlands the members of the association of catering companies with a common market share of 90% agreed to implement a set of hygiene and quality standards in order to demonstrate that they are 'good' in comparison to other companies that are not members of this association (Simons and De Vries, 2002, p. 48).
- Parties in a supply chain may agree to common standards. Supermarkets and their suppliers in the Netherlands, for instance, have agreed to introduce standard crates for fresh food products (Koehorst, De Vries and Wubben, 1999).

- Partners in a consortium may agree to the use of a set of standards. For example, a group of American process industries and their contractors have agreed to the use of certain standards for their installations (Simpkins, 2001).

In the 'market' situation two issues are of importance that will be addressed in the next sections: the art of tracing standards, and the 'battles' between competing standards.

4.2 Quest for standards

As tens of thousands of standards exist it can be very difficult to trace the right ones. In order to find relevant standards for, for example, a product, you might insert the name of the product and the term 'standard' in a search engine. There is a good chance that you will find one or more standards in this way. However, are these standards the right ones?

- You find a supplier who tells you he uses a certain standard. Will other suppliers use the same one? Should you use this standard, or is there no need for this?
- There appears to be an official ISO standard. Is it common practice to use this standard? Or are there good reasons for using another specification, if any ?
- You find 10 standards. There might be more.

So the only thing you find is a first indication about the standard you are looking for, no more. A more systematic search approach is needed. Such an approach may include the following steps (De Vries, 2003):

1 Look for standards related to legislation
On the European market, CE marking applies to more than 50% of all products. In this case, standards are related to the legislation. Moreover, these standards may refer to other relevant standards.

2 Look for formal standards
Your national standards body has a catalogue of national standards, including national implementations of international standards. The simple fact that these are national standards means that national stakeholders have agreed to develop them and have approved them. Or they have decided to implement certain international standards. Apparently they had good reasons for doing so, so it might be important for you to use these standards. Formal standardization organizations use the International Classification of Standards (ICS) (ISO, 2001) to structure their standards catalogues. Unfortunately, ICS mixes standardization topics with the field of activity or, in other words, mixes entities with the human use of them. By definition, a standard concerns two or more entities and, moreover, one standard may have different fields of application.

Therefore, ICS is insufficient to trace all relevant standards. Moreover, standards other than the formal variety may be relevant as well. So, additional steps are needed.

3 Determine parties you expect that might set standards.
Apart from formal standards and company standards there are standards set by consortia, branches of business organizations, professional associations or governmental agencies. So in your quest for standards you may try to find these organizations. In most cases they will be related to the supply chain of the product concerned.

4 Determine possible topics for product-related standards
Product-related standards may concern:
- parts of the product,
- sizes,
- materials used,
- mechanical movements (interfaces, quality requirements, safety requirements),
- electricity (compatibility, safety),
- quality characteristics,
- environmental characteristics,
- ergonomics,
- health,
- information (e.g., product identification, terminology, product documentation, information for users, interface between product and information (e.g., marks, labels, barcodes, RFID tags (RFID = Radio Frequency Identification))),
- information traffic.

5 Look for the standards
Look whether or not the organizations you have found issue standards on the topics you have listed.

6 Determine market relevance of the standards found.
In the case of competing standards, the question is which one to use. In general, the choice is up to the company (or other organization). It may be of help to ask experts. Once you have accomplished the above steps you should be able to ask such experts the right questions. Such experts may be found, for example, in standardization bodies or branches of business organizations. If they do not know the answers themselves, they might know the specialists who are able and hopefully also willing to answer your questions.

4.3 Competing standards

If several standards are available to solve the same matching problem, the question is which one will 'win' in the market. Scientists, especially economists, have described and analysed several examples of such battles. Examples include standards for cellular telephone services (West, 1999), microcomputers (Hergert, 1987), interactive videotext (Schmidt and Werle, 1998), and high definition television (McKnight, Baily & Jacobson, 1996). Shapiro and Varian (1999) provide various short examples. One single standard has obvious advantages, such as economies of scale, transparency and the avoidance of the costs of converting to an alternative standard. However, the standardization process often results in a battle between various designs because the advantages of a particular standard are unevenly distributed between the involved parties, so that the efficient standard may not emerge.

The number of users of a standard is called the *installed base* (Farrell & Saloner, 1986). There may be one solution that is commonly used (example: QWERTY typewriter keyboard), a limited number of sets of different solutions (example: ANSI X 12 or EDIFACT syntax rules for EDI messages), or a large number of different isolated solutions (e.g., the use of function keys as shortcuts in software operations). Once the installed base has been created, users tend to stick with one standard even when the technology has become old-fashioned or inferior. The reason for this is that conversion to a new standard is costly. This is called *lock-in* (Arthur, 1988). QWERTY is a famous example of lock-in: conversion to an easier keyboard would require expensive and time-consuming courses for typists to learn the new system. A *dominant design* is 'the distinctive way of providing a generic service or function that has achieved and maintained the highest level of market acceptance for a significant amount of time' (Lee et al. (1995, p. 6)). Users determine a dominant design's emergence. Once a limited number of them have chosen to implement a certain solution, others tend to choose the same. They *bandwagon* the early adopters' choice.

The reasons for bandwagoning are, in logical order (each reason presupposes the foregoing) (de Vries, 1999):

- Availability of the solution: often, the only reason for bandwagoning is the availability of the solution. Bandwagoning avoids reinventing the wheel.
- Increasing returns on information: a solution that is more adopted enjoys the advantage of being better-known. This stimulates its spread (Arthur, 1988, p. 68).
- Avoiding uncertainty: an already implemented solution has proven to be feasible. Most users dislike experimentation and uncertainty (Cowan, 1991, p. 811; Cowan, 1992, pp. 285-291) and, therefore, bandwagon the early adopters' choice.

- Economies of scale: in general, standard solutions are cheaper than tailor-made ones.
- Functionality: in the case of compatibility, there is a functional need for bandwagoning as interoperability is not possible without sticking to the specifications used by another actor, or only possible by adding a 'converter.'
- Network externalities: in a telephone system with n users, the number of possible connections for one user is n-1, the total number of connections is n (n-1). So the total functionality of the system is proportional to the square of the number of users. The more overall functionality, the more functional profit individual users gain from their investments and the more willing they are to bandwagon the system (Katz and Shapiro, 1985).

Apart from such direct network effects, indirect network effects can occur. The value of, for instance, a barcode system increases with the availability of scanning equipment. The more barcode users there are, the more scanners will be available and the lower their price. Thus, without improved system functionality for the individual users, they profit from growth in the number of users (Nicklas, 1997, p. 195). Some technologies need standardization to obtain enough critical mass. Without standardization they would not diffuse. Therefore, it can be profitable for a company to have competitors that offer clone products, using the innovator's technology, since network externalities mean that this enhances the user-quality of the company's products (Connor, 1994, pp. 180-181). In the case of network externalities, the lock-in effect is extra strong. Conversion to a new, better, technology is only profitable when a large number of players do the same, so nobody dares to change since, unless a collective action is organized, one does not know whether others will follow.
Because of the bandwagon effect, the first standard available has an advantage over later, competing standards, if any. The first agent will not always be the winner in terms of profit. In spite of having income from early adopters, and advantages in terms of image as innovator, goodwill and brand loyalty, other early entrants using the same standard can free-ride on the first mover's investment in infrastructure and training (Gabel, 1994, p. 144). In a market with great uncertainty, the second mover can learn from the first mover's mistakes and gain a competitive advantage by improving product quality or by positioning this second mover's offerings closer to the customer's preferences (Nicklas, 1997, p. 200).

In a case about microprocessor standards, Swann (1987, p. 260) also mentions the attractiveness for new entrants to produce a second-source copy of an industry standard rather than introduce their own product. It is not a law of nature that first agents dominate the game of competing standards. Often, several standards can co-exist, each of them having a part of the market. In the case of network externalities, however, it is more probable that one standard will win, because this is the most profitable situation from a users' point of view, not counting the drawbacks from monopolistic situations. Of crucial

importance for the success of standards in such situations, however, is not their current rate of use, but the expectation of their future use. In such a situation a standard proposed by a powerful party, having little or no current market share, may defeat an existing standard that has a considerable market share. The shift from WordPerfect to Word in text processing was an example of this; the expectation that Word would win was related to the shift from MS DOS to Windows. Moreover, Word offered additional functionality and partly backward compatibility to WordPerfect. A powerful party like Microsoft can be called a *dominant agent*. Dominance may be due to, for instance, market share (Braunstein & White, 1985), power image, or status. It is possible for two standards to exist in the market concurrently. When competing standards differ in the advantages they generate for different categories of users, each of them may develop their own installed base and subsequent lock-in effects, which may prevent one of them from winning (Arthur, 1988, pp. 69-73).

In a market with network externalities and competing standards, the preferred solutions are:
- an adapter that enables conversion from the implementation of one standard to that of the other standard, assuming that costs of an adapter are not too high (Baake & Boom, 1997), or
- a joint modification (Cowan, 1992, p. 281).

These solutions increase the functionality of the system for customers. For suppliers, they enhance the likelihood that the technology, as such, generates enough customer confidence to obtain the critical mass necessary for a breakthrough. Such gateway technologies that bridge the two incompatible technologies generate ex post compatibility (Nicklas, 1997, p. 197). Competing standards may cause market and buyer uncertainty as they do not know which one, if any, will win - they face the danger that products which fail to receive enough support cease to be further supported and improved (David, 1995, pp. 25-26). Licharz (1997) has argued this in a case about IBM's OS/2 standard for operating systems. OS/2 competed with the Windows 95 standard and reinforced the loss of market share of IBM's own DOS standard. On the other hand, an early choice of one standard can build confidence to invest in a new technology. The early setting of an American standard for colour television was, on the one hand, the reason why colours in the USA are prone to deterioration in transmission through the ether. On the other hand, this situation strengthened the leading role of the US in producing programmes and films and provided the public with the new technology at an early stage (Overkleeft & Groosman, 1987, p. 113), even though it took another ten years for any real breakthrough (Farrell & Shapiro, 1992, p. 54).

5 Standards implementation

5.1 Introduction

Once an organization has decided to implement a standard, the question is: how. For most standards, this is a question for technical experts who have to use the technical requirements laid down in the standard in their design for a product, service or process. In the first place it is not self-evident that these experts will actually do this. For instance, it is more an exception than a rule that software designers use the international standard ISO 8601 (ISO, 2004) for the format of dates and time in their software. This standard states that years should be written using four digits; two digits are permitted only when no misunderstanding can be expected. The shift from 1999 to 2000 cost millions of dollars in inspecting, modifying and testing software. This exercise would have been completely unnecessary if the developers of software had implemented ISO 8601. In the case of standards that prescribe human behaviour, e.g., procedures or instructions, actual implementation of these standards is even less evident. Most complicated are the standards that impact the entire organization or large parts of it. This applies to standards for management systems, such as, quality management systems, environmental management systems or occupational health and safety systems. A topic to be aware of is which version of a standard is implemented. The international standard for the resistance of copper, IEC 28, has remained unchanged since 1925 and its technical contents since the first edition in 1914 (IEC, 1925). The International Financial Reporting Standards, on the contrary, tend to be changed frequently, which causes problems in comparing the financial figures of different years (Hoogendoorn, 2004). In the next section we will take an example of the implementation of a procedural company standard.

5.2 Example: implementing a standard procedure

The process of drafting and implementing a procedure may consist of the following successive stages (De Vries, 2002):

1 Determining the format and contents of the procedure

2 Preparation of the draft-procedure

3 Testing and, if necessary, adapting the procedure
The procedure prescribes the preferred way a process is carried out. The present way may be different. If there is a gap, the procedure itself and/or the actual method of working should be adapted. Subsequently, everybody who has to work with it should check the procedure and, where necessary, give comments.

Necessary improvements or deficiencies in the procedure or method of working are thus determined. This is sometimes called a procedure audit.

4 Field test
After the procedure has been established, tested and adapted, the described method of working should be field tested for a predetermined fixed period of time, e.g. a few weeks.

5 Evaluation
After the field testing, experience is evaluated: is working with the procedure practical enough to meet its purposes? If necessary, the procedure should be modified or, in the most extreme case, withdrawn.

6 Approval
The procedure should seek formal approval, preferably through a consensus process in which all relevant parties participate.

7 Implementation
Now the procedure is officially released. From now on, the documented operating procedures should be followed in the company. If necessary, elucidation or training may be provided. The accepted procedure is included in the procedure manual, if any.

8 Internal audit
After some time a check is made as to whether the work is being performed in accordance with the procedure.

9 Evaluation
After a longer period of time, an evaluation is carried out of the extent to which the intended purposes have been met.
Many people dislike working according to procedures as it restricts their freedom. On the other hand, they will recognize their importance - total 'chaos' would hinder the organization's function. So a balance between 'order' and 'chaos' should be found and the best way to get full support for this is to involve the employees as much as possible in the process of drafting the procedure as well as in the decision-making. Moreover, the procedure concerns their daily work so they are the experts par excellence. This writing can be done individually but also in groups: in a small work group with people who are dealing with the same procedure, where necessary, complemented by two people who are directly involved in the immediately preceding and the directly following process steps. A work group operates best if there is an experienced secretary who does the preliminary work, documents the results and presents them again to the group. The process owner is the obvious work group convener. Experience with work groups of this kind is mixed. Some believe it is the optimal route because in this way the procedures become the result of common expertise; the procedures

established in this way ensure a large degree of involvement. Others think it is difficult and takes too much time. The choice of whether or not to use work groups will be connected with the company culture, with the employees' level of education and with the qualities and personal preferences of the quality manager and the process owners. Where writing by the operators themselves is not practicable, e.g. because it is too difficult, well-prepared interviews are a method which still allows for procedures to come about from the 'bottom up'. The required systematics and the inter-relation between different procedures can at least partly be developed from the bottom-up as well. An example is when employees can participate in a brainstorm session to find connections and to distinguish processes, indicating the importance of each connection/process.

6 Impact of standards

'He who does not pay attention to internal standardization is doomed to have too expensive production processes and to make too expensive products. He who does not participate in external standardization is doomed to work according to the standards of his competitors' (Prof.dr.ir. C.A.J. Simons, former professor in standardization at Erasmus University, Rotterdam). We will later pay attention to the impact of standards. This impact can be studied on both the macro and micro levels. A main source for the macro-economic impact of standards has been provided by Blind (2004). Other sources include DIN (2000), Swann (2000), Temple and Williams (2002), and WTO (2005).
For the micro level, we list some aspects in the next sections, subsequently on the impact of standards for companies, consumers and governments.

6.1 Impact of standards for companies

Companies can be both direct and indirect users of a standard. In company practice, the main aim of using standards is to contribute to business results and to the effectiveness and efficiency of the organization. Standards can reduce the costs of products and services. Meeting or not meeting certain standards can be the difference between success or failure in the market.

General aims of standardization include (after Sanders, 1972):
- reduction of the growing variety of products and procedures;
- enabling communication;
- contributing to the functioning of the overall economy;
- contributing to safety, health, and protection of life;
- protection of consumer and community interests;

- eliminating trade barriers (although standards at the national or supranational level can also create trade barriers).

More specifically, the following issues illustrate the importance of standards for companies (Schaap and De Vries, 2004):

Within the company:
- not re-inventing the wheel, but using existing solutions (laid down in standards) which have already been well thought out;
- bringing procedures in line with what is normal elsewhere, so that cooperation is simpler and purchasing cheaper;
- efficient working, by repeatedly using the same solution;
- using recognized requirements in the field of, for example, quality and safety;
- cheaper purchasing, due to economies of scale, and more transparency in the market which results in increased price competition;
- less cost of stock and logistics by making use of standard solutions;
- more possibilities for outsourcing;
- fewer problems in the field of occupational health, safety and environmental issues.
- when standards are correctly followed/applied, the vulnerability of the company related to the presence of certain people (illness, vacation, job rotation, etc.) can be avoided/diminished.

Outside the company:
- being able to demonstrate the quality of products and services (using test methods laid down in standards);
- giving clients confidence: the product (and/or the production method) meets accepted requirements;
- being allowed to bring products onto the market, because conformity to standards may be a means of demonstrating conformity to legal requirements;
- being able to bring products onto the market, because they meet requirements (laid down in standards) that are important for customers;
- being successful with products, because they meet customers' wishes and are compatible with other products.

Standards may also have disadvantages for companies.
Within the company:
- Too much formalization may cause too much routine for employees, resulting in dissatisfaction.
- Standards for processes may hinder process improvement.
- Standards for products or services may hinder product innovation.

Outside the company:
- If a company is not able to meet the requirements in a standard, it will lose market share.
- If a competitor is better able to meet the requirements, the company will face a competitive disadvantage.
- Standards may make the market more transparent and thus cause an increase in price competition, at the cost of profit margins.

6.2 Impact of standards for consumers

For consumers, standards may contribute to (ANEC, 2003):
- accessibility/design for all;
- adaptability;
- consistent user interfaces;
- ease of use;
- functionality of solutions;
- service quality;
- system reliability and durability;
- health and safety;
- environmental issues;
- information (product information, directions for use, system status information);
  - reliability of information;
  - privacy and security of information;
- interoperability and compatibility;
- multi-cultural and multi-lingual aspects;
- more transparency in the market, enabling consumers to better compare products and services from different suppliers on price, quality, and other characteristics.

Additionally, standards may also lead to lower prices, due to economies of scale and increased price competition.

6.3 Impact of standards for governments

Most of the benefits and risks of standards for companies largely also apply for governments when governmental agencies use standards for improving business processes and performance.

The following issues also seem to be important for governments (De Vries, 1999):
- governments may support standardization as a part of their general role in stimulating business performance and international trade;
- governments may supplement, simplify or improve their legal system with standardization by making references to standards in laws;
- through standardization, the market may govern itself with less regulation from the government;
- international standards may help to remove trade barriers.

7 Concluding remarks

In the first place, this lecture was intended to provide a general introduction to standards and standardization. We have showed what standardization is, and why and how it is applied. We have structured this chapter using a standardization model. Our second intention was to provide some fundamental concepts concerning standards and standardization. We have defined standard and standardization and some other essential concepts and referred to more comprehensive studies.

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9 Glossary

Anticipatory standardization
In anticipation of an expected future matching problem, a standard is developed so that the matching problem can be solved from the outset. Synonym: prospective standardization.

Bandwagoning
Phenomenon in which once a limited number of parties have chosen to implement a certain solution, others tend to choose the same solution.

Basic standard
Standard that provides a structured description of (aspects of) interrelated entities to facilitate human communication about these entities, and/or to be used in other standards. Examples of basic standards include:
- terminology standards
- standards providing quantities and units (e.g., SI: Système Internationale d'unités: the International System of Units)
- standards providing classifications and/or codes, (e.g., currency codes)
- standards providing systematic data (e.g. ergonomic standards describing man's characteristics and abilities, such as dimensions of the human body; these data are used in other standards)
- standards providing reference models (e.g. the OSI (Open Systems Interconnection) reference model: a 7-layer model developed to solve the problem of the interconnection of computer systems).

Certification
Procedure by which a third party gives written assurance that a product, process or service conforms to specified requirements (ISO/IEC, 2004).

Company standard
Standard developed for use within a company or other organization for their own needs (Düsterbeck et al. 1995, p. 107).
'Developing' does not mean that each company standard has to be designed from scratch. A company standard may have the form of (de Vries, 1999, p. 231):
- a reference to one or more external standards officially adopted by the company;
- a company modification of an external standard;
- a subset of an external standard (for instance, a description of the company's choice of competing possibilities offered in an external standard, or a subset of the topics covered in the external standard);
- a standard reproduced from (parts of) other external documents, for instance, suppliers' documents;
- a self-written standard.

Company standardization
Developing standards for use within the company and developing standards to be used in the company's relations with its direct business partners (De Vries, 1999, p. 231)

Compatibility standard
Standard which concerns fitting of interrelated entities to one other, in order to enable them to function together. Examples: a film in a camera, GSM mobile phone specifications.

Concurrent standardization
Standardization to solve matching problems as soon as they occur.

Consensus
A general agreement, characterized by the absence of sustained opposition to substantial issues by any important part of the concerned interests and by a process that involves seeking to take into account the views of all parties concerned and to reconcile any conflicting arguments. Note: consensus need not imply unanimity (ISO/IEC, 2004). To summarize: consensus is agreeing not to disagree any longer.

Consortium standard
Standard issued by a consortium: an alliance of companies and (sometimes also) other organizations.

De facto standard
Dissuaded term. See consortium standard.

De jure standard
Dissuaded term. See formal standard.

Direct user (of a standard), or Implementer
Party that reads the standard to apply it. A party can be a person, a group of people, or an organization.
Dominant agent Party that can force other parties to make choices they otherwise would not have made.

Dominant design
The distinctive way of providing a generic service or function that has achieved and maintained the highest level of market acceptance for a significant amount of time (Lee et al. (1995, p. 6).

First agent
The first player to set a standard for a certain topic.

Formal standard
Standard issued by a Formal standardization Organization (De Vries, 1999). Formal Standardization Organization ISO, IEC, their national members, regional standards development organizations related to these national members, ETSI or ITU (De Vries, 1999). The term 'formal' refers to the organization's recognition. This should not be seen as governmental recognition, but as recognition - in the case of national standards bodies - by ISO or IEC and, conversely, recognition by national standards bodies (which applies for ISO, IEC, CEN and CENELEC).

Governmental standard
Standard issued by a governmental agency other than formal standardization organizations.

HACCP
Hazard Analysis Critical Control Points. Standard for food safety management.

ICS
International Classification of Standards. Standards classification used by formal standardization organizations to structure their standards catalogues (ISO, 2001). Implementer (of a standard), or Direct user Party that reads the standard to apply it. A party can be a person, a group of people, or an organization.

Indirect network effects
Phenomenon the benefits for an individual user of a certain product increase once other parties bandwagon the design of an interrelated product. For instance, a barcode system increases with the availability of scanning equipment (Nicklas, 1997, p. 195).

Indirect user (of a standard)
Party that has a stake in the application of the standard, but that does not read the standard. A party can be a person, a group of people, or an organization.Installed base Number of users of a standard (Farrell & Saloner, 1986). Interference standard Standard which sets requirements concerning the influence of an entity on other entities. Interference standards include safety, health, environmental, and EMC standards (EMC = electromagnetic compatibility; these standards concern electrical disturbances).

Lock-in
Tendency for users to stick with one standard even when the technology has become old-fashioned or inferior, because of the cost of conversion to a new standard (Arthur, 1988).

Measurement standard
Standard that provides a method to be used to check whether a requiring standard's criteria have been met.

Network externalities
Phenomenon in which benefits for an individual user increase once other parties bandwagon the same design. (Katz and Shapiro, 1985).

Non-disclosure agreement
Agreement between participants in a consortium to share knowledge in order to develop a common standard and/or technology and keep this knowledge confidential until the moment they agree to publish the standard and/or to introduce the technology in the market.

Open standard
Standards developed in a process where all interested parties had the opportunity to be represented. The term 'open standard' may cause confusion - Krechmer (2006) mentions nine other possible meanings of 'open' standards, related to standards development or related to standards implementation or use.

Openness
Possibility for all interested parties to be represented in standardization (De Vries, 1999, p. 41).

Performance standard
Standard that sets performance criteria for the solution of matching problems, without prescribing certain solutions. Performance standards can include specifications of the extent to which deviations from the basic requirements are permissible.

Prospective standardization
In anticipation of an expected future matching problem, a standard is developed so that the matching problem can be solved from the outset. Synonym: anticipatory standardization.

Quality standard
Standard which sets requirements for entity characteristics to assure a certain level of quality. Examples include ISO 9000 quality management standards, measurement standards, and company procedures.

Requiring standard
Standard that set requirements for entities or relations between entities. These can include specifications of the extent to which deviations from the basic requirements are allowed. Requiring standards can be divided into performance standards and standards that describe solutions.

Retrospective standardization
Standardization to solve existing matching problems.

Sectoral standard
Standard issued by an organization that unites parties in a certain field of business.

Standard
Document, established by consensus and approved by a recognized body, that provides, for common and repeated use, rules, guidelines or characteristics for activities or their results, aimed at achieving the optimum degree of order in a given context (ISO/IEC, 1969b). Unfortunately, not all standards fit into this definition: not all standards are consensus-based or approved by a recognized body and standards may have a format other than a document, e.g. software as in the case of Windows. Therefore, De Vries (1997) has developed another definition: a standard is an approved specification of a limited set of solutions to actual or potential matching problems, prepared for the benefits of the party or parties involved, balancing their needs, and intended and expected to be used repeatedly or continuously, during a certain period, by a substantial number of the parties for whom they are meant.

Standardization
The activity of making standards may be called standardization.
Standardization concerns establishing and recording a limited set of solutions to current or potential matching problems directed at benefits for the party or parties involved and intending and expecting that these solutions will be repeatedly or continuously used during a certain period by a substantial number of the parties for whom they are meant. A matching problem should be understood as a problem of interrelated entities that do not harmonize with each other; solving it means determining one or more features of entities in such a way that they harmonize with one other or of determining one or more features of an entity because of its relation with other entities (De Vries, 1997).

WTO enquiry point
Each member of the World Trade Organization shall assure that an agency in the country is available to answer all reasonable questions regarding technical regulations, standards, and conformity assessment from other members and interested parties in other members, as well as to provide the relevant documents (General Agreement on Tariffs and Trade, 1979).

10 Key questions

- In formal standardization, decision-making is consensus-based. How is it possible to reach consensus when participants disagree?
- What is standardization?
- Why should we be educated in standardization?
- Why do plugs and sockets differ between countries?
- Is it true that the use of ISO standards is enforced by governments?
- What is a standard?

Vu Tuan Anh[1]

Abstract

The roots of standardisation can be found in the ancient cultures of China and Mesopotamia, for example. Over the ages, standardisation has further developed and spread around the globe. In this module, we will look at standardisation in ancient times, pre-industrial times, the period of the Industrial Revolution until 1900, the period of the two world wars between 1900-1945, and the period of 1945-1970. For the later periods, the description focuses on the emergence of standardisation organisations at the international and national levels.

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1 Introduction to the History of Standardisation

Even though the term 'standards' was not used in ancient times, standards for making or doing things were applied in several cultures. Standards were set to meet different objectives and purposes in society. This module will provide some insights into the development of standards through the early ages of human history to the year 1970. The periods are divided into different time segments: ancient times, pre-industrial times, industrial times to 1900, the period of 1900-1945, and the post-Second World War period to the year 1970.

2 Early Examples of Standards

Whenever two or more humans have to cooperate, they must agree on certain fundamentals, be it explicitly or implicitly. Moreover, in many aspects of human life, imitation is the norm, and creative invention is the exception. This leads to uniformity in language (vocabulary, grammar, etc.), legislation (e.g., 'standard' penalties), and religious rituals, for example. However, we would not include these areas in the concept of standardisation because there is no conscious process behind them, and the 'economic' qualification of balancing needs is lacking. We have defined the term 'standard' as an approved specification of a limited set of solutions to actual or potential problems, prepared for the benefit of the party or parties involved, balancing their needs, and intended and expected to be used repeatedly or continuously during a certain period by a substantial number of the parties for whom they are intended. In this sense, ancient societies engaged in a very limited use of standards, if any, because economic activities remained strictly local. Nevertheless, there were some exceptions, as mentioned in the following.

In ancient times, various cultures developed standards for weights and measurements, e.g., 3200-2800 BC in Mesopotamia (Ritter 1996). These standards facilitated trade. The dimensional standards were often taken from the human anatomy, frequently the king's body, e.g., the 'cubit' was the distance from the elbow to the wrist and varied from 0.444 metres (Palestinian cubit) to 0.641 metres (Roman cubit) (Spivak and Brenner 2001, 7). Another unit of measurement was the 'span', the distance from the tip of the thumb to the tip of the little finger with the fingers extended. This method of measurement is also known in the Vietnamese folktale 'The golden star fruit'. Once standards for measurement were available, specifying standard sizes was the next step. For example, in Roman times, people built water pipe systems running through cities of a standard size of five fingers' width (Hoang 1973, 62).

This section will give a general overview of these standards using examples from three different regions in the ancient world: Egypt, China, and Greece.



Figure: King's arm as unit of measurement (Source: ANSI)

2.1 Standards in Ancient Egypt

In the Palaeolithic era, about 500,000 to 700,000 years ago, Egyptians built 'tent rings' to live in. According to archaeologist Waldemar Chimielewski (Hoang 1973, 62), these tents are the oldest buildings ever to have been found in the world. They all have similar shapes and sizes - 'oval depressions about 30 cm deep and 2 × 1 metres across' (Mitch and Nathan 2002, 1). Were these sizes just customs which may have seemed self-evident to the people constructing the tents, or did these buildings meet explicit rules? If the latter is true, this is the first example of standardisation.

We may also wonder how ancient Egyptians built the pyramids without using any sophisticated technologies. The stones have unique sizes and angles to enable the pyramids to stand where they have been standing up to now. From these two observations, we must conclude that the ancient Egyptians knew how to apply certain principles of standardisation in the dimensioning of their tents and in the construction of the pyramids (Hoang 1973, 62).

2.2 Standards in Ancient China

About 5,000 years ago, the Chinese people invented a way to measure distances. They introduced a set of 12 flutes with similar diameters, and the longest one was set to be the standard to measure length in China at that time. The length of the longest flute was measured by the length of 81 sesame seeds sorted in order of length or 100 sesame seeds sorted in order of width. The ancient Chinese people put 120 sesame seeds in the longest flute to set it as the unit to measure the cubic capacity of objects, and the weight of 100 sesame seeds was used as the standard weight (Tuan 1973, 61).
The first emperor of China, Qin Shi Hoangdi, who died in the year 210 BC, united the various states of the Han Chinese to form a single empire. He used standards to reinforce this unity, to encourage trade and movement, and to promote prosperity. Examples included technical standards for weights and measures, for water conduits and road construction, and for the axle and wheel bases of transport vehicles, which, in turn, led to standards for the width of town gates (Ellias 1999).
This is a clear example of political reasons for standardisation. However, standards also served both economic and military purposes.

2.3 Standards in Ancient Greece

Greece has contributed to the development of human knowledge in many fields, standardisation included. Parts of texts in a stele which is kept in the museum of Eleusis specify the way to produce bronze fittings, including their chemical composition (eleven parts copper to one part tin) (Varoufakis 2005). These inscriptions can be considered the oldest standards in Europe, produced in the 4th century BC.
A white marble stele from 375 BC provides a method of assessing the quality of Athenian silver coins. This measurement standard might have been used for producing and testing materials. Two other inscribed steles which are kept in the museum of Thasos provide requirements for producing and selling wine: the jars containing the wine should be sealed, with the quality of the wine and the date marked on the seal (Varoufakis 2005).

2.4 Conclusion for the Ancient Period

It can be concluded that standards in ancient times were an exception, because most economic activities had a very local character. However, examples of standards can be found in various cultures, and the most widely used standards concerned weights and measures. As a society grew more complex, different simple ways were used to certify that products were originally produced with a reasonable quality. Overall, standards in this period facilitated trade, and in many of the cases we know of today, these standards were prescribed by the local sovereign.

3 Standardisation Prior to the Industrial Revolution

Prior to the Industrial Revolution, the 16th and 17th centuries may be considered the beginning of a modern world. New regions and continents were discovered. New countries were created through civil wars. In this section, we will look at the causes and nature of standards activities in Europe and Asia in this period.

3.1 Standards in Europe

In the period before the Industrial Revolution, standardisation was used primarily by the military. This was due on the one hand to the elaborate organisation of the armies, and on the other to technological exigencies. Calibres are one example of this. There was originally a great variety of calibres which differed in aspects such as length. Around 1498, the Holy Roman Emperor Maximilian I decided to reduce the types of calibre in a systematic way (Van der Sloot 1964, 104-105). In 1666, a decree ruled that all guns in the French army should have the same calibre: 20 bullets were to be made out of one pound (Delbrück 1920, 270).
In the 15th century, the Republic of Venice (in the north of what is now Italy) equipped its war ships with standardised rudders, masts, sails, etc., and standardised spare parts were kept available for the fleet in depots in various ports (DIN 1991). This increased speed (ASA 1972).
Standards were also used for civil purposes. During the Middle Ages in Europe, guilds developed their own professional standards, often at a local level. The naval dominance of the Seven Provinces (which constituted the Netherlands) at the end of the 16th and the beginning of the 17th century was supported by the design of a merchantman, the 'Fluitschip', with great manoeuvrability and with a crew of only ten sailors/gunners (Wegener Sleeswijk 2003). For this series of ships, standard sizes were used.

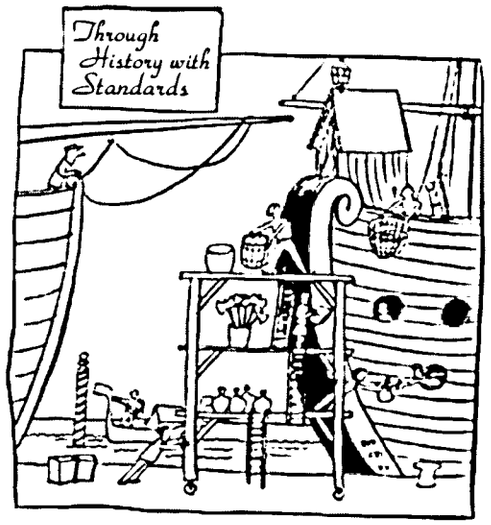


Figure: Fluitschip (Source: ANSI)

3.2 Standards in Asia

The 16th and 17th centuries can be viewed as a 'downtime' for Asian countries, especially South Asian countries. Civil wars lasted for long periods; long wars and strict control of the empires made life hard. For example, in the latter half of the 16th century, China experienced the Manchu, who took over the Ming dynasty and ruled the country for two and a half centuries (Mason 2000, 87-89). Japan experienced the competition for power in much more violent ways. Asian countries faced the downturn of their dynasties and economies and the invasion of Central Asian and Western cultures and religions. Because of these developments, Asian countries engaged in very few standardisation activities.

3.3 Conclusion for the Period prior to the Industrial Revolution

During the period prior to the Industrial Revolution, both Europe and Asia faced several wars. In Europe, the wars led to the formation of new countries with more stable societies and better economies.
These countries applied standardisation primarily in their armies, but also for civil purposes. In Asia, fewer standardisation activities took place.

4 Standards in the Time of the Industrial Revolution to 1900

During the period from 1800 to 2000, there was an enormous shift from labour-intensive home production to mass production in factories, which is less labour-intensive. This so-called Industrial Revolution needed standards to enable mass production. The first examples can be found in military production (Section 4.1), for example. In 1810, 96% of all textiles in the United States were manufactured at home, but 20 years later, almost everything was produced in factories - a real revolution. Factories produced for markets. The factories were designed in rational ways, producing standard products in standardised ways. This meant that standardisation was introduced at a company level. However, sometimes standards in the companies were not enough. This was the case with nuts and bolts (Section 4.2), truck gauges (Section 4.3), and fire hydrants (Section 4.4). Therefore, agreed-upon inter-company standards or standards at the national level were introduced, e.g., in building (ASTM Standardization News 1998) and textiles (Pratt 1998).
In the areas of traffic and transport (e.g., railways), energy provision, and telecommunications, large technical networks emerged for which international standards could be an advantage. We can examine the first steps taken in this direction. Several international organisations were formed, such as the International Union of Railway Freight Transportation (1845) and the Universal Postal Union (1878). In the area of telecommunications, standardisation at the international level emerged (Section 4.6). In the 19th century, international cooperation also received its own impetus due to political factors (Lyons 1963).
In some cases, scientists were the initiators, e.g., in the development of coherent systems of units (Section 4.7) and in the area of statistics (Stigler 1996). Subsequently, industrialists and engineers from different fields joined forces at the national level, first in Great Britain (McWilliam 2001).

4.1 Standards in Military Production

Between 1861 and 1865, the Americans experienced their great civil war. The increasing demand for guns and weapons pushed American gun manufacturers to find a way to produce guns more effectively. In 1788, Thomas Jefferson, who was at that time the American ambassador to France, wrote a letter describing the practices of a gunsmith named LeBlanc:
'An improvement is made here in the construction of muskets, which may be interesting to Congress to know, should they at any time propose to procure any. It consists of making every part of them so exactly alike that what belongs to any one may be used for every other musket in the magazine. Supposing it might be useful to the United States, I went to the workman. He presented me the parts of fifty locks taken to pieces, and arranged in compartments.

I put several together myself, taking pieces at hazard as they came to hand, and they fitted in the most perfect manner' (Gilbert 1958, 437-438, cited by Spivak and Brenner 2001, 10).
Another company that was aware of the great benefit of interchangeable parts was the Russian gun manufacturer Tula, which produced 7,000 guns per month during the year 1812 by applying this concept. In the year 1837, another Russian gun manufacturer, Ijep, produced 30,000 guns per month (Hoang 1973, 64). The technique of interchangeable parts was not new at the time, but it was well practiced, which led to a huge amount of guns being produced with the same amount of people and the same machines.

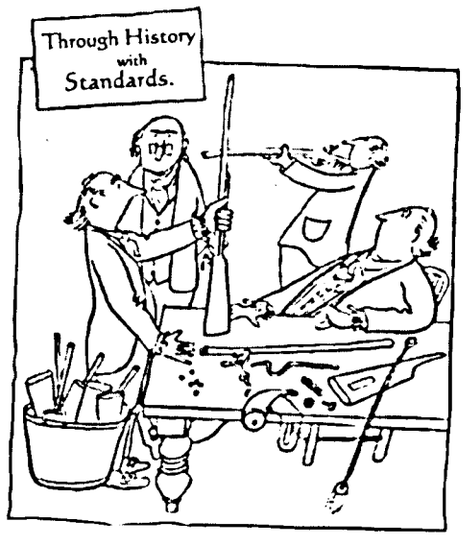


Figure: Guns Manufacturing (Source: ANSI)

4.2 Nuts and Bolts

In 1797, Henry Maudslay invented a method of producing screws in a systematic way. Until then, screws had been laboriously manufactured by hand, so each screw was unique. Bolts for the same machine would turn out differently. Therefore, when taking the machine apart, every bolt and its corresponding nut was painted or marked in order for there to be any chance of putting the machine back together again. Mixing up the nuts and bolts would have created confusion and wasted time, as each bolt possessed a different specific thread (Hesser and Inklaar 1997, 27). Later on, in the latter half of the 19th century, there was an increased demand for higher productivity in screw production and

use. Joseph Whitworth collected and compared screws from many workshops throughout England and searched for the best thread for screws. In 1841, he proposed to the Institution of Civil Engineers that they use a constant angle (55°) between the sides of the threads and suggested a specification for the number of threads to the inch for the various screw diameters (Gilbert 2001, 437-438). This resulted in the same size for bolts and nuts so that they could be used interchangeably.

4.3 Standards for Truck Gauges

Agreeing on common standards was not an easy task. Cropper (1979, cited by Spivak & Brenner 2001, 11-12) describes the difficulty of achieving standardisation in practice, especially in the truck gauge industry. In about 1795, William Jessop invented metal rails for transportation. One of the choices to be made concerned the gauge. The distance was taken from the cartwheel ruts in the English roads of the day, and this is still our standard railway gauge: 4 feet 8.5 inches. This distance originates from the Romans, as shown by wheel paths found in Pompeii.
However, England's Great Western Railway was built in the early 1800s with a rail gauge of 7 feet. In Canada and on some U.S. lines, the approved gauge in the first half of the 19th century was 5 feet 6 inches. By the time of the American Civil War, there were no less than 33 different gauges in the US. In 1863, the US Congress mandated the 4 feet 8.5 inches gauge. This choice was based on empirical considerations and was made mainly to aid military logistics. In 1867, after the Civil War, the Society of American Civil Engineers was revived, and professional groups set up several working committees to define common standards for gauges, couplers, brakes, and block signal systems (Chandler 1977, 132; Salsbury 1988, 56-60). In 1880, time was standardised as well, which made it easier to make timetables and integrate the railroads into a national network (Schmidt and Werle 1998, 26). By 1890, most railroads had adopted the new standard (Salsbury 1988, 55).
Such conversions had to be made in other countries as well - a costly exercise. However, without these changes, tremendous economic disadvantages would have remained: freight would have had to be unloaded and reloaded at junction points; rolling stock could only have been used for short hauls instead of long runs. So large and avoidable costs resulted from short-sighted but honest errors in judgment, or they were deliberately chosen for self-serving or pre-emptive reasons (Spivak and Brenner 2001, 11-12).



Figure: Truck gauges (Source:ANSI)

4.4 Fire Hydrant Hose Coupling

The absence of standardisation not only brings disadvantages for the economy in some senses, it can also be catastrophic to human lives. One of the most fatal disasters in American history was the fire in Baltimore city in 1904. The Baltimore fire department had to call Washington, D.C., Philadelphia, and New York for assistance. Fire fighting equipment was sent to Baltimore as quickly as possible by express train. However, the equipment could not be used because the hoses did not fit in Baltimore's hydrants. After this disaster, the problem was corrected by the National Fire Protection Association and others: they developed and implemented standards for the fire hydrant hose coupling (ASA 1972, 60).

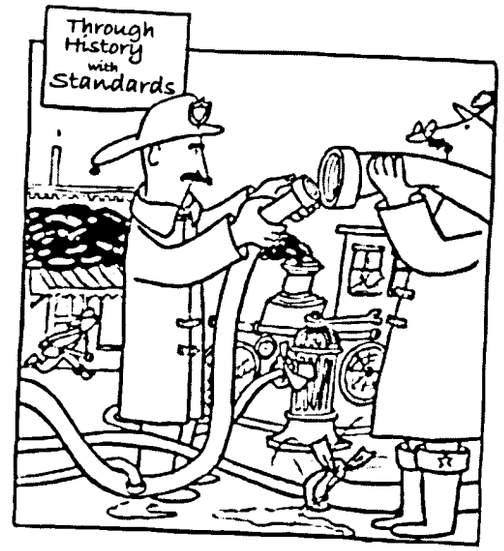


Figure: Fire Hydrant Coupling (Source:ANSI)

4.5 Competitive Disadvantages in the Absence of Standardisation

Hesser and Inklaar (1997, 25) provide a Russian example from the period 1883-1886 which clearly demonstrates the need for standardisation in the early years of industrialisation. Quoting the German engineer and mechanical designer Hermann Haeder in a conversation with a Russian dealer, who was the proprietor of a major machinery outlet in Rostov, Russia, the dealer said:
The German traction engines are very good, but not suited to this locality. I will give you an example of what I mean: the crankshaft for driving the threshing machine on a 12-HP traction engine was broken.
Telegram to Germany: 'Send crankshaft for 12-HP traction engine 580 at once.'
The reply read: 'Send exact drawing with dimensions.' We had to get hold of a suitably qualified engineer, have the drawing made and send it to Germany. After three months had passed, the spare part finally arrived here. In the meantime the harvest had ended.
'It's a different matter with the English traction engines. Each individual part bears a number. At the same time, the purchaser receives a manual containing diagrams and the respective numbers of all the individual parts. In some of the larger Russian cities there are depots for all the spare parts, even the boiler. The stocks of these spare parts are continuously replenished. In an emergency, all that is required is a telegram giving the number of the part and the number of the traction engine. The spare part is dispatched as soon as the telegram is

received, and operations can be resumed within a few days. That's especially valuable in southern Russia, where so many businesses are concerned with farming. Far greater value is placed on spare parts being delivered in time than on saving fuel.'
This example demonstrates that standardisation can be essential, and it can bring competitive advantages to companies in terms of reducing costs and increasing customer satisfaction.

4.6 International Standardisation for Telecommunications prior to 1900

The discovery of electricity in different experiments and its application at the end of the 18th century and the first half of the 19th century by great inventors such as Benjamin Franklin, Luigi Galvani, Alessandro Volta, Michael Faraday, Georg Simon Ohm and many others enabled the development and growth of sciences and technologies, including telecommunications. In 1844, Samuel Morse transmitted the first message from Washington to Baltimore over the telegraph line. This event marked the beginning of the telecommunications era. Within ten years, telegraph services were available to the American public. In those days, transferring a message from one country to another country was a troublesome task. Messages had to be transcribed, translated, and handed over at borders. Each country had its own system of coding, and the telegraph line was not connected from one country to another, so re-transmission was needed over the telegraph network of the neighbouring country (ITU 2004).
System specifications for cross-border connections were laid down in bilateral agreements. However, in the field of telecommunications, bilateral agreements are no longer sufficient when the networks of more countries have to be interconnected. Prussia (which extended across present-day northern Germany and parts of Poland), for instance, had fifteen different agreements for linkages between the capital and the borders. In order to be able to develop interconnected networks, mutual agreements between countries were needed. Therefore, countries started to develop regional agreements resulting in several regional conventions (ITU 2004).
The further growth of the telegraph networks pushed 20 European states to join together to develop common solutions. After a series of negotiations, the first International Telegraph Convention was signed in 1865. This agreement enabled international interconnection by providing common rules for the standardisation of equipment, standard operating instructions, and common international tariff and accounting rules. The International Telegraph Union (ITU) was formed to take care of this convention and its subsequent amendments (ITU 2004).
Not long after the formation of the ITU, in the 1870s, two inventors, Elisha Gray and Alexander Graham Bell, both independently designed devices that could transmit speech electrically: the telephone. This was seen as a step up

in technology over the telegraph. In 1876, Alexander Graham Bell patented his telephone first, and soon after that, his invention was widely used in public service (ITU 2004). On the American market, competing companies came up with deviating specifications (Schmidt and Werle 1998, 30-31). Being a network technology, the telephone needs common compatibility standards, and quality standards also apply. This was a new activity for the ITU, which it began in 1885 (ITU 2004).

4.7 Example: Standards for Quantities and Units

Prior to the French Revolution in the 1790s, there were no common units of measurement being used in the world. European countries still used the measurement standards which had been developed by the ancient Romans: feet and inches. However, these feet and inches differed somewhat in size from one town to another, and there were other units of measurement as well.
In 1862, the British Association for the Advancement of Science (BAAS) appointed the first commission consisting of physicists from various countries with worldwide reputations. One of its first achievements in 1863 was the adoption of a system based on three fundamental units: the metre, gram, and second. The need to measure smaller lengths led to the creation of the centimetre, and in 1874 a new system of measurement was formed, the centimetre-gram-second (CGS) system (Teichmann 2001, 9).

4.8 Conclusion for the Industrial Revolution

Standards were an essential element in the 'American way of manufacturing' with exchangeable parts. Therefore, company standards were needed. In some cases, however, standards at the national, supranational, and even global level also emerged. This is related to the growth in national and international trade. Standards became an economic instrument to facilitate trade or, in some cases, to hinder trade by having different standards in different countries. Technical developments which enabled the emergence of 'network technologies' in transport, electricity supply, and telecommunications were another reason to start initiatives for standardisation at the national, supranational, and international level. The first results at the international level concerned telecommunications. The invention of the telegraph paved the way for communication over long distances. Separate country-based networks created barriers to international communication. This problem was tackled in the form of bilateral, multilateral, and international agreements.
The next section will introduce the development of standards in the period 1900-1945.

5 Standardisation in the Period 1900-1945

The period between 1900 and 1945 was marked by two world wars. These wars influenced standardisation in the sense that they stimulated industrial achievements at the national level in those branches of industry related to military production and, at the same time, hindered production in other areas. More specifically, they hindered cooperation at the international level.
In the period 1900-1945, standardisation at a company level continued; however it no longer concerned only technical issues, but also the way of working (see Section 5.1).
In some countries, the first initiatives for cooperation to develop standards at the national level started at the end of the 20th century, but the formation of national standardisation bodies started at the beginning of the 20th century. Because it did not participate in the First World War, the Netherlands managed to be the first country to have an independent national standardisation organisation in 1916. Other countries soon followed. To illustrate this, we shall describe this process for Great Britain in Section 5.2. The activities of such an institute were related to national priorities. In South Africa, for instance, mining activities were most important. In 1905, the Transvaal Chamber of Mines created a committee to standardise machinery and other materials in order to reduce costs and solve problems related to the diversity of types and sizes of equipment. The committee established eight subcommittees to manage different fields: pipes and fittings, shafting, mine materials, tracks and rails, mill materials, building and structural materials, weights and measures, and glass fittings and wire ropes. This was a predecessor to the national standardisation organisation (SABS 2005).
At the international level, the ITU continued its work (Section 5.3), standardisation began in the area of electrotechnology (Section 5.4), and the national standardisation organisations initiated a form of international cooperation for standardisation in certain other fields (Section 5.5).

5.1 The Taylor System - Process Management Standardisation

Frederick Winslow Taylor, an American engineer (1865-1915), developed 'The Principles of Scientific Management' (Taylor 1911) in order to 'achieve maximum prosperity for the employer with maximum prosperity for the employee'. This was supposed to be achieved by measuring the optimal productivity of the organisation of labour through the division of labour, time and motion studies, the introduction of standards, and motivation theory. 'The sequence of movement, time required and tools to be used in every job of work should be established by time and motion studies and the results recorded and defined in a standard. Workers should be carefully selected and trained in their jobs.

The motivation to work and job satisfaction should be created by a defined system for rewarding performance' (Hesser and Inklaar 1997, 30).
This study pointed out two important principles: The first is the joint effort of workers and management to achieve the greatest prosperity for both sides and the community as a whole. 'The second principle, which made the first possible, was that both sides should have confidence in a new science which laid down the requirements and conditions for the task of labour in an unbiased and incontestable manner' (Hesser and Inklaar 1997, 29). 'Taylorism' has received a great deal of criticism as well: Though it was not Taylor's intention, it may turn out that employees are treated 'merely' as (human) resources.

5.2 Standardisation in Great Britain

In the late 19th and early 20th centuries, the Industrial Revolution made England the most industrialised country in the world. The steam engine and locomotive attracted great attention from inventors, manufacturers, and other people. By 1900, there were about 75 different types of tram gauges throughout England. Travelling from one place to another remained difficult, because people had to change trains many times. Each railway track used different gauges. To deal with this, the Engineering Standards Committee (ESC) was established early in 1901. Its first meeting agreed to reduce the number of tram gauges from 75 different kinds to 5. Furthermore, the committee also discussed the variety of structural steel sections and decided to reduce the number of sections from 175 to 113. This was estimated to save steel merchants £1 million a year (BSI 2005).
In 1902, the committees received support from the government in terms of finance and legislation. The committee functioned as the world's first national standardisation organisation, which was formed and maintained by industry and approved and supported by the government. In 1903, the first national standard was produced: British Standard 1 (McWilliam 2001, 77). From 1901 to 1914, the ESC developed 64 British standards. Most of these standards concerned railway lines, engines, the telegraph, telephone materials, and electric cable. At the end of 1914, the ESC had 60 committees in total (BSI 2005).
The year 1903 also marked the introduction of the first symbol to be used to tell people that certain goods were up to standard. This was to be known later on as the Kitemark. This mark was first registered as a trademark for tramway rails (McWilliam 2001, 111).
During the First World War, British standards were used by the Admiralty, the War Office, the Board of Trade, Lloyd's Register, the Home Office, the Road Board, London County Council, and many colonial governments. The major contribution of the ESC during this period was to lay down standards for materials used in fighter planes. They established a committee for the standardisation of aircraft and aircraft engine components in 1917, and later on this

committee was responsible for the standardisation of all aircraft materials. During wartime, BSI stopped its ordinary work and concentrated more on 'War Emergency Standards'. However, BSI was also helping the Board of Trade to clarify the standards for utility goods and consumer goods. This was the first step BSI took towards consumer protection (BSI 2005).

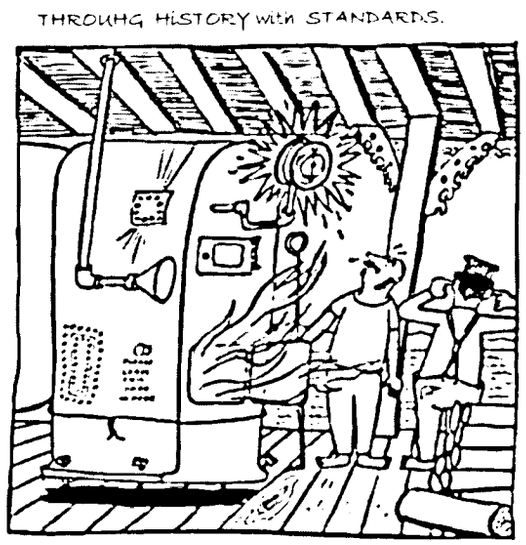


Figure: Steam Engine (Source:ANSI)

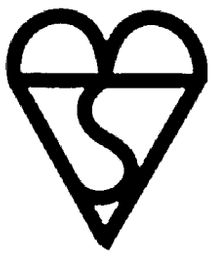


Figure: Kitemark (Source:www.en.wikipedia.org)

In 1918, the ESC changed its name to the British Engineering Standards Association (BESA), and from then on the country had a national standardisation body. BESA's annual report of 1920 shows that at that time in history, national standards already played an important role in international competition. Of the many available examples, we take some of those listed by McWilliam (2001, 67-68):

- Due to the absence of any British standard for component parts of locomotives, the British locomotive builders lost large contracts in China to their American competitors.
- American standards for gear wheels for electric tramways gave American steel manufacturers an almost complete monopoly in this market, including Britain. A new British standard was introduced to compete against the Americans.
- The publication of a British standard for electric transformer oils led to the almost complete disappearance from the English market of American suppliers of this material.
- The standardisation of electric cables had placed British manufacturers in a very favourable position in competing with European and American manufacturers in overseas markets.

In 1921, BESA established the Mark Committee. This Committee had the responsibility of granting licenses to companies which wanted to show that their products conformed to British standards. The size and scope of the organisation expanded up to 1930, and most of the standards created were engineering-related. Moreover, in the face of the growing demands surrounding the theories and practices of chemical products, the organisation decided to include chemical standardisation as an additional activity. In 1931, the name of the organisation was changed to the British Standards Institution (BSI) to reflect its wider scope of activities.
In the 1930s and during the First World War, BSI published its first non-industry-specific management standards (McWilliam 2001, 73).

5.3 International Standardisation for Telecommunications, 1900-1945

In 1896, wireless telegraphy - better known as radio telecommunication - was introduced for the first time. In 1903, the ITU began standardisation for this new technology. In 1906, the first International Radiotelegraph Convention was signed, and the ITU achieved its first regulation on wireless telegraphy. Later on, these so-called Radio Regulations were expanded, revised, and amended several times (ITU 2004).
In the year 1920, at the studios of the Marconi Company, voice broadcasting was improvised. In 1927, the International Radio Consultative Committee (CCIR)

was established to coordinate technical studies, tests, and measurements in the various fields of telecommunications and to draw up international standards. In the same year, the International Radiotelegraph Conference assigned frequency bands to the various radio services (fixed, maritime, aeronautical mobile, broadcasting, amateur, and experimental) for better control and effective operations (ITU 2004).
In 1932, the International Telegraph Convention and the International Radiotelegraph Convention were combined and given the name International Telecommunication Convention. In 1934, the name International Telegraph Union was changed to International Telecommunication Union (ITU) in order to better reflect the scope of the organisation: all forms of wired and wireless communication at that time (ITU 2004).

5.4 International Standardisation for Electrotechnology prior to 1945

In telecommunications, standardisation occurred at the international level from the outset, and the same would occur in electrotechnology, with some preceding activities at the national level, e.g. in the United States (Hughes 1983). Theories and inventions were made by brilliant individuals such as Alessandro Volta, André-Marie Ampère, Georg Simon Ohm, Thomas Edison, Nikola Tesla, and Guglielmo Marconi. These theories and inventions opened a new era of technical and industrial development.
However, these applications also raised problems reflecting the usage of different nomenclatures, standards, and measurements for the same concepts. Diversity in the specification of electrical equipment hindered the development and growth of the technology. 'Although the importance of electrical measuring units had been universally recognized, by the end of the 19th century the lack of standardization of electrical equipment had become a worldwide problem. With the development of economic generators, filament lamps, fittings and reliable cables, local authorities and distributors for the first time could choose between the merits of different designs. But in the absence of agreed ratings and recognized performance criteria, they were often obliged to follow the advice of experienced consultants. Manufacturers, on the other hand, began to appreciate that to facilitate repetitive production, simplification of designs was essential, especially in reducing cost for the consumer, meeting competition from foreign producers, and providing recognized guarantees' (Frary 2005).
However, electricity can be dangerous, and therefore there was a need to pay attention to safety issues in a systematic way.
In order to deal with all of these problems, standardisation was needed. But who would take the initiative 'for the benefit of all'? As far as a coherent system of units was concerned, it was the Italian scientist and engineer Giovanni Giorgi who took the lead, based on his four-dimensional theory of

electromagnetic phenomena (Teichmann 2001). However, having motivated and intelligent people is not enough in itself; organisational embedding may also be required.

The starting point for the latter turned out to be an electricity exposition, the 'Palace of Electricity', organised in St. Louis in 1904. The trigger was the shared experience of the disadvantages of a lack of standardisation. At the exposition, many types of power were needed to supply the exhibitors. Each country brought exhibits requiring different power: direct current and alternating current; alternating current at 25 and 60 cycles; alternating current with 1, 2, and 3 phases; and numerous direct-current voltages (Erdmann 2005).
In the same month, the fifth International Electrical Congress was also organised in St. Louis, with 29 delegates from 15 countries. The meeting laid down the objective 'to secure the cooperation of the technical societies of the world, by the appointment of a representative Commission to consider the question of standardization of the nomenclature and ratings of electrical apparatus and machinery'. Subsequent to this meeting, the International Electrotechnical Commission (IEC) was officially founded in 1906. Its central office was located in London, England.
The period between 1906 and 1909 was seen as the dawn of the IEC. In this period, sets of rules and regulations were defined and created to enable the operations of the IEC. Many meetings were held to ensure the standardisation of the electrical terminologies to be used in different institutions, research centres, and national committees. The IEC's activities attracted the attention of the electrical society; more and more countries attended the IEC's meetings.
By 1914, four technical committees were formed by the IEC to deal with nomenclature, symbols, the rating of electrical machinery, and prime movers. A list of terms and definitions for electrical machinery was issued, and international symbols, signs for quantities, and units of measurement were published.
The First World War interrupted the work of the IEC. However, its operations resumed soon after the war. In October 1919, a plenary meeting was held in London with delegates attending from 20 countries.
By 1923, the number of technical committees had risen to 10. In order to help the Council in giving effect to its decisions and coordinating the work of the national committees, a Committee of Action of seven members was formed. This action helped to accelerate the work and assist the IEC's Central Office in expediting its work with a minimum of expense.
In 1926, delegates from 19 countries attended the meeting in New York; other general meetings followed in European countries.
One of the IEC's publications was the International Electrotechnical Vocabulary (IEV), published in French, English, German, Italian, Spanish, and Esperanto. It was widely circulated, and later on it was used as the basis for much of the electrotechnical nomenclature work in a number of countries.
During the Second World War, the work of the IEC came to a standstill for six years.

5.5 Establishing the International Federation of the National Standardizing Associations (ISA)

Early in 1926, the British Standards Institution (BSI) and the American Standards Association (ASA) initiated a conference in New York with the participation of other national standardisation organisations from around the world to draft a constitution for a world standards association. In 1928, this draft was approved at a conference in Prague. The International Federation of the National Standardizing Associations (ISA) was established with the following objectives:

- to provide simple and systematic means for exchanging information on standards and standards activities in different countries
- to provide guiding principles to assist national standards bodies
- to promote uniformity among national standards
- to cooperate with other international organisations concerned with rationalisation and standardisation.

The ISA developed technical recommendations and distributed these to the national standardisation organisations for adoption. However, 'the ISA's activities were mainly limited to continental Europe and it was therefore predominantly a 'metric' organization. The standardizing bodies of the main 'inch' countries, Great Britain and the United States, never participated in its work, though Britain joined just before the Second World War' (ISO 2005b, 3). At the ISO General Assembly meeting in 1976, Mr Heiberg (ISA's founder) from Norway admitted that the ISA 'never fulfilled our expectations.' In 1940, the Second World War suspended the ISA's activities.

5.6 Impact of Standards on the Second World War

During the first years of the Second World War, Germany and its partners maintained the advantage, but after the British won the Battle of Britain, the situation changed. Allied forces succeeded in bombing Germany, especially the Ruhr region, the area with the greatest concentration of industry serving the war effort. The Germans therefore decided to decentralise war production. Different military equipment parts were produced in different places and assembled at a later date. The different parts were expected to fit and, consequently, specifications were laid down in (military) standards. In one particular small factory, standard measures were produced based on these standards. The standards themselves were stored in this factory as well, along with data concerning replacement frequency related to wear. The Allies did not know this, but by coincidence they hit this factory. As a consequence, the German war industry no longer received its standard measures. This caused delays in production and problems with waste material and logistics, not only in the country but also at the front: spare parts no longer appeared to fit, and the

diminished precision of tanks led to a greater need for ammunition. This military example (Simons 1984, 6) illustrates the impact of standards on the functioning of industries.

5.7 Conclusion for the Period 1900-1945

The trends toward more technical integration, more international trade, and more international cooperation led to an increase in standardisation beyond the company level. Standardisation spread to branches of business organisations and official standardisation organisations at the national level and, increasingly, also at the international level. However, this development stagnated during the First and the Second World War. During these periods, most standardisation resources were used for military standardisation.

6 Standardisation in the Period 1945-1970

The Second World War ended in 1945. Millions of people were killed, especially Russians and Jews. Many parts of Europe were totally destroyed. There was a shared feeling that this should never happen again and that countries should cooperate. As a result, several international organisations were formed and existing ones were strengthened, including standardisation organisations. International standards facilitate international trade, and countries that cooperate in business may be less inclined to start hostilities again. This type of cooperation in standardisation also started at the European level and was related to political cooperation.

At the national level, standardisation activities increased in the form of preparing national input for international standardisation. In this chapter, we limit our description to the international level: the IEC, ITU, and ISO in the period 1945-1970. We then turn our attention to the national level.

6.1 International Electrotechnical Commission in the Period 1945-1970

A number of activities were carried out after 1946 to ensure the early resumption of the work of the International Electrotechnical Commission (IEC) after the war and to create a close relationship with the United Nations Standards Coordinating Committee (UNSCC), which was temporarily formed on 30 October 1943 in the Moscow Declaration issued by China, Great Britain, the United States,

and the USSR. In 1947, the International Organization for Standardization (ISO) was formally constituted and took over the functions of the UNSCC and ISA. A meeting in Zurich in 1947 determined the affiliation of the IEC with ISO as ISO's Electrical Division. However, administration and technical autonomy remained with the IEC. In the context of this affiliation, it was important to the IEC to have good communication and an exchange of information with ISO. At the beginning of 1948, therefore, the IEC moved its office to Geneva, Switzerland; its central office was - and still is - in the same building as ISO's (Ruppert 2005, 3-6).
From 1950 to 1970, the IEC continued to expand its research and accepted more technical committees; the number of technical committees rose from 34 to 80. Many standards covered measurements, safety requirements, and the testing and specification of components for radio receivers and televisions. Furthermore, the IEC began to include new technologies, such as capacitors and resistors, semiconductor devices, and electrical equipment in medical practice and maritime navigation. In 1961, a technical committee for computers and information processing was formed, and in 1968 a TC on industrial automation was created. Consequently, both technical and market developments led to a continuous growth in activities (Raeburn 2006, 1).

6.2 International Telecommunication Union in the Period 1945-1970

In 1947, the United Nations was formed, and the International Telecommunication Union (ITU) became a specialised UN agency. In 1948, the ITU's headquarters moved from Bern to Geneva. The International Frequency Registration Board (IFRB) was created to manage the radiofrequency spectrum.
Telecommunications developed further, both in the technical and the business sense. A radical innovation was the introduction of satellites for creating global communications networks. Again, standards were needed, and the ITU provided these (ITU 2004).

6.3 International Organization for Standardization in the Period 1946-1970

Some months after the end of the Second World War, in October 1945, delegates of the UNSCC (United Nations Standards Coordinating Committee) gathered together in New York to discuss the future of international standardisation. At this meeting, delegates from the UNSCC decided to approach the ISA to form a new organisation with the proposed name 'International Standards Coordinating Association'. One year later, from 14 to 26 October 1946,

25 countries gathered together in London. The first morning of the meeting was not easy; members of the ISA decided to liquidate their organisation at once due to the limitation of activities and suspended operations. However, the meeting was immediately resumed as a conference of the UNSCC and other national standards associations. In this period of the conference, Willy Kuert (Secretary of the Swiss Standards Association) proposed a way to set up the committee, and subcommittees were formed to work on the final constitution, the formula for calculating member subscriptions, the official languages to be used, and the location of the office. At the same time, the UNSCC and ISA held separate meetings to discuss bringing their activities to an end. By 26 October, the conference ended with fruitful results. The new organisation was named the International Organization for Standardization (ISO). The tag ISO does not just mean 'International Standards Organization'; it means equal in Greek, which represents the purpose of the newly formed organisation. ISO officially began its operations on 23 February 1947 (ISO 2005b).

The early years of ISO were mainly focused on the establishment and reorganisation of the system. In 1947, 67 technical committees (TCs) were formed for standardisation in a great variety of technical areas and one service area: libraries and documentation (ISO 2005a, 61). In subsequent years, other technical areas were added, along with some service areas, e.g., banking. Standards development appeared to be a rather slow process; by ISO's fifth birthday, only two recommendations had been produced.
In the years up to 1970, there was an increase in the number of TCs, the number of standards, and the number of ISO members. ISO developed into an organisation not only for industrialised countries, but for all countries, including developing countries. During the period of the Cold War, in which the tensions between the US and the Soviet Union became stronger and stronger, ISO remained a forum where delegates from countries in the East and West met and cooperated in establishing international standards.

6.4 National Standardisation Organisations in the Period 1945-1970

In the years after the war, the number of countries with a national standardisation organisation slightly increased (because standards are indispensable in a modern society, and without a national standardisation organisation, a country has to depend on foreign countries). In many less-developed countries, national standardisation organisations were established by their governments to serve as the authorised organisation to encourage, and in some cases also to force, their industries in the public and private sectors to follow certain international or national standards.

In socialist countries, sophisticated systems of thousands of national standards were set up, e.g., in the USSR (State Committee for Standards of the USSR Council of Ministers 1976). These standards were compulsory, and the standardisation organisations were governmental organisations.
In Western countries, national standards had a voluntary status, and in most cases the NSOs were NGOs. In general, the bigger the country in terms of gross national product, the larger its standards collection. National standards could be proposed to become ISO standards, and in this way a country could have an influence at the international level. In particular, countries in northwest Europe were active at the international level (De Vries 1999). Gradually, there was a shift in their activities from developing national standards to involvement in international standardisation (ISO and often also the IEC).
As an example, we will turn our attention to the national standardisation organisations in one country, Great Britain, to examine their activities and development after the Second World War.

6.4.1 Example: British Standards Institution (BSI)

In England, many cities were devastated and needed rebuilding. Standards played an important role in saving time and materials which were used to rebuild the country. In the same period, BSI extended its activities to new areas such as nuclear energy, safety, the environment, symbols for use on packaging, and safety colours for industry.
During the first decades after the war, the market was flooded with consumer goods, but many were of dubious quality. The Kitemark was used to ensure the quality of products. By the end of 1950, 540 Kitemark licences had been issued for products covered by 73 standards (McWilliam 2001, 86).
The establishment of the Women's Advisory Committee in 1951, representing 18 women's organisations in Britain, showed a certain commitment to consumer issues such as product safety, and BSI facilitated direct consumer representation in standardisation activities. In 1955, the Advisory Council on Standards for Consumer Goods was set up with the purpose of testing the safety of consumer goods (McWilliam 2001, 87). However, conflicts of interest limited BSI's effectiveness as an advocate for consumer interests (McWilliam 2001, 71).
BSI set up a test centre with the purpose of ensuring that products conformed with British standards or with the standards of another country in the case of exports. By the end of the 1960s, the activities for granting the Kitemark also included the surveillance of production and quality-control arrangements in the manufacturers' plants (McWilliam 2001, 71).

In order to increase the impact of British standards in other countries and, in this way, capture overseas markets, BSI promoted the translation of British standards into other languages, e.g., into Turkish (McWilliam 2001, 74).

Gradually, BSI began to focus less on standards development and standards selling and more on consultancy, testing, and certification (McWilliam 2001, 73).

6.5 Conclusion for the Period 1945-1970

After the Second World War, many countries had to build up their infrastructure almost from scratch. Standards could support this, and many new countries established a national standardisation institute to support their economy. After the war, there was a willingness to collaborate at the international level, and the International Organization for Standardization (ISO) was one of the bodies that was established. Standardisation activities increased rapidly, both at the national and at the international level. In Europe, a limited start was made with standardisation at the supranational level.

7 Conclusion

As long as economies have a local character, standardisation in general is not needed. However, once trade relations are established or armies want to use technology in a systematic way, standardisation becomes feasible. Therefore, standards were hardly used in ancient times, but some early examples of standardisation can be found. In the medieval period, standards were primarily used in the military, but also in the guilds and in shipbuilding, for example. The emergence of standardisation is related to the Industrial Revolution. 'Repetition' in products as well as production methods can be supported by standards at a company level. As soon as companies are no longer seen as islands but are interconnected in a technical sense or through trade relations, there is a need for standards that surpass the company level. In the area of telecommunications, this need is related to the network character of the technology, and we therefore see standardisation at the international level from the outset here. In electrotechnology this apples to a certain extent as well, so we can also observe standardisation at the international level here at an early stage of technological development, but somewhat later than in telecommunications. In other areas, standardisation started at the company level, continued on the national level, and then later moved to the international level. Throughout history, we can observe that the evolution of standardisation is not only related to but is also stimulated by technical, economic, and political developments.

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9 Glossary

ANS
American National Standards Institute

BSI
British Standards Institution

IEC
International Electrotechnical Commission

ISA
International Federation of the National Standardizing Associations, an international organisation established in 1928 to stimulate the exchange of information on standards and standardisation in different countries and to promote uniformity among national standards. ISA served as a prototype for the establishment, in 1946, of the International Organization for Standardization (ISO).

ISO
International Organization for Standardization

ITU
International Telecommunication Union

Standard measure
Basis for comparison

Stele
Pillar of stone, usually carved or inscribed and used for commemorative purposes, e.g., to mark a grave.

10 Key questions

- What is ISO?
- What are ISO's objectives
- How was ISO formed?
- What is ITU?
- What is IEC?

Thai Hung Pham

Abstract

Standardization and its output - standards - have been crucial for economic development in our society. The rapid technological progresses of the global and increasingly complex knowledge economy have produced a wide range of standards on products, services, and processes in every corner of the world economy. The economics of standardization have been developed since the 1980s rapidly. So far, there has been a relatively rich body of economic theories on different aspects of standards, but the empirical literature on the multi-dimensional impacts of standards on economic performance is still limited. The recent publication by Blind (2004) is probably the most comprehensive empirical literature on the impact of standards on economic performance. Given the currently existing literature on economics of standardization, this unit explores a selected number of economic issues related to standards and their impacts mainly on economic performance. While it is doing so, the learners will firstly be familiarized with basic economic concepts underlying standards and the standardization process. These concepts are essential to gain a full understanding of the two proceeding chapters which cover some fundamental economic aspects of standardization, including the interrelation between standards and technical change, competition, and international trade. Under globalization and economic integration among economies around the world, standards have become increasingly international. At present, standards have a central role in the dynamics of international flows of goods, services, and technologies. In response to the international context of standardization, this unit will allocate a considerable volume of content to investigating the impacts of standards on one of the most important economic activities in our era: international trade.

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1 Preface

As standards have become crucial for economic activities in every corner of the world, economists have developed literature which explains the possible impacts, both positive and negative, of the standardization process and its output - standards in the terminology of economics. Among others, standards bring huge positive economic benefits through network externalities, a resolution for information asymmetry, a means of reducing transaction costs. In the presence of standards, firms are more likely to obtain economies of scale, which allows them to approach mass production and mass distribution. In addition, the existence of standards can also provide a function of facilitating technical change, and hence are crucial for economic development.
However, as is traditional practice in economic debates, standards like any other economic issues have been the subject of criticism from economists. From the view of consumer welfare, the existence of standards reduces the range of public choice and thus consumer welfare as a standard specification may be exclusively dependent on their distinct needs and references. Moreover, there are cases in which only one or a small numbers of firms are able to control or at least influence the standardization process at the expense of the others. As a result, market competition will suffer, leading to market power and considerable losses to consumer surplus. In other cases, the existence of barriers limiting free access to standards introduces an obstacle to the technical changes needed to achieve efficient economic performance at the company, industry, and macro-economic levels.
In the context of international economics, standards have also been at the centre of a debate as their impacts on international trade flows can be either positive or negative or both. The existence of mutually recognized standards is crucial for international flows of goods and services. For developing countries, applying international standards also opens up opportunities for technological catch-up. Nevertheless, standards have been blamed for their impacts as important and effective protectionist devices. In many cases, standards can play the role of technical barriers to trade that are likely to be beneficial for domestic producers at the expense of their foreign counterparts.
This unit explores these issues in three major chapters. In the proceeding Chapter 2, basic economic concepts underlying the standardization process and its output - standards - will be explained by distinguishing between four different types of standards. This chapter provides a background for understanding some important economic aspects of standards presented in Chapter 3 and Chapter 4. As technical change and competition have been long considered the driving forces of economic performance at both macro and micro levels, Chapter 3 investigates the interrelation between standards and technical change, and then standards and competition. The impacts of standards on economic performance are extended to incorporate the context of globalization in Chapter 4. In this chapter, both positive and negative effects of standards on international trade are examined. The essential nature of standards under the governance of the WTO is also covered in Chapter 4. Chapter 5 produces concluding remarks. To facilitate the learning process, a glossary with detailed explanations of keywords is developed together with a set of review questions and exercises at the end of the unit.

2 Economic concepts of standards

This chapter explores the basic concepts underlying standardization by investigating classifications of standards according to the types of economic problems they resolve, popularized by David (1987). This classification has been agreed and widely used in the economic literature on standardization (see Nicolas and Repussard 1988 for a survey). Distinguishing between these different types of standards will address some of the basic economic concepts necessary for a full understanding of the issues dealt with in other chapters.

2.1 Compatibility and/or interface standards

Compatibility and interface standards were initially developed in the railway industry as a typical example of network industries. The rapid progress of information and communication technologies has increased the importance of this kind of standard, and made it into a central issue of the economic literature on standardization. As this type of standard is essential in economic studies of standardization, this chapter will place a special focus on explaining the economic reasoning embodied in compatibility and interface standards. There are two important economic concepts underlying compatibility and interface standards. These are the so-called network effects or sometimes network externalities and switching costs.

2.1.1 Network externalities

The theory on network externalities was first developed by Katz and Shapiro (1985), Farrell and Saloner (1985), and Farrell and Saloner (1986a,b). There are two main types of network externalities, including direct and indirect network externalities. The direct network effects arise when users benefit from being linked, physically or psychologically, to a large number of other agents. For example, in the case of phone or e-mail networks, because consumers want to be able to communicate with a large group, they would perceive a larger network benefit as the number of network users increases. Direct network effects can also arise with the importance of 'fashion'. It means that consumers might just

derive some satisfaction from buying the same product as others. The rapid growth of the iPod MP3 player over the past two years provides a good example of such direct network effects. Where there are only few users, the utility of the network for the current users is thus limited. Katz and Shapiro (1985) express the utility as an individual function by assuming a positive relationship between consumer i's utility associated with the network good i, which can be written as:

$$u_i = a_i + b_i N^e \text{ with } b_i > 0$$

In this function, a_i represents the stand-alone value consumer i derives from consuming one unit of the good; N^e is the expected size of the network, and b_i is this consumer's valuation of the network effect. Typically, it is assumed, for simplicity, that each consumer buys one unit of the good so that N^e is also the expected number of buyers. In this equation, a_i is the independent parameter that can take either positive or negative values and differs from one to another. This utility component represents the utility of the network when nobody else joins the network. The second component represents the network effect that will increase continuously with the expected size of the network, measured by the number of participants. In the presence of direct network externalities, the private marginal benefit (which determines whether a consumer joins the network or not) of one additional consumer joining the network is smaller than the social benefit. This is because the social benefit from this additional network user comprises the user's private benefit and the increase in benefits of the existing users. Under such circumstances, the market would end up with a network size that is smaller than the socially optimal size.

In contrast to direct network externalities, which are network benefits generated from additional users joining the network, indirect network externalities are obtained when each user must join two or more components belonging to different networks to derive potential network benefits. With respect to indirect network externalities, if a consumer buys a certain product today, it does not alter the current utility of the others. However, today's buying decision has certain effects on the variety and prices of compatible components in the future. Consequently, the consumer's decision today affects his/her utility in the future. In this case, there is also an incentive for consumers to choose the most popular product in an attempt to obtain more benefits from the supply of other supplements in the future. Therefore, under a static framework, there is a zero indirect network effect. Indirect network effects arise only under a dynamic framework when users make purchasing decisions or consumers enter the market continuously (Blind, 2004). In this case, there will be an incremental impact of one user's purchasing decision on the future assortment and prices of products, components, and services related to the whole system. As shown by Katz and Shapiro (1994), the most common example of indirect network effects is illustrated by the so-called hardware-software paradigm. In this case, a customer who decides to buy hardware forms certain expectations about

availability, prices, and quality of the software packages and other related components that they will probably buy in the second period. If this purchase decision becomes a collective action, it may lead to large investment in human capital and software development for the type of hardware chosen in the first period. It thus enables the current users to benefit from lower prices of software available in the future. In the presence of direct and/or indirect network effects, producers will generally supply products that are in accordance with the common industry standards. As more producers certainly offer identical products, the level of competition within the industry will increase. As the network size increases, more consumers will join the network for direct benefit from network externalities or for future benefits (i.e. indirect network externalities). In this case, it is important to note that the winning firms are not necessarily those with the best technologies from the perspective of technological performance. Instead, they may be those that are successful in developing a wide network of customers, and/or able to lead and/or influence other suppliers in order to establish the common industry standards.

The recent development of ATM in Vietnam is an example of how network benefints would be increased with a greater transferability of the ATM network. Up to September 2004, the largest ATM owner was Vietcombank (Vietnam Bank for Foreign Trade) with a number of more than 400 ATM machines nationwide. The remaining number of around 450 ATMs is opreated by all the other banks. This incompatibility between the Vietcombank`s network and the remaining banks' introduces perceived quality differences between the Vietcombank's ATM services and those of the others. As a result, the Vietcombank has the largest number of ATM customers.

In competing with the Vietcombank, it is essential for the other banks to create network benefits for customers. As a result, the other banks jointly developed the Banknet, which is a newly established ATM network that ensures the transferability among their ATMs. With the Banknet, the other banks aimed at increasing the compability among their networks. With increased transferability, these banks have been able to increase their ATM customers after a very short period of time. At the moment, the number of their customers is about the same as that of Vietcombank.

To further increase the transferability of the ATM networks, the SBV (State Bank of Vietnam) has had a plan to put them together in order to standardize their ATM networks. As long as this plan is effectively implemented, the ATM users would benefit more from the higher network effect, caused by the greater transferability between the two ATM networks.

Figure: The newly established ATM services in Vietnam (Source: Vietnam Economics Times 2004)

2.1.2 Switching cost

When discussing network externalities, we implicitly assume that consumers are free to move among different standards offered. This is, however, not always the case. In fact, producers and customers face switching costs (Klemperer, 1987). Before being committed to a particular standard, consumers are free to choose alternative configurations offered in the market. But after they have purchased the product with a particular standard, it will become increasingly expensive for them to switch to another. Klemperer (1987) distinguishes between the three types of switching costs: transaction costs, learning costs, and artificial or contractual costs.

An example of transaction costs is the cost of switching between the ATM services of the Vietcombank and other banks in the Banknet (as discussed in Box 1). As the other banks developed the Banknet, their potential network benefit increased. But certain costs are incurred for the existing service users of the Vietcombank to switch to the Banknet's services. Therefore, as long as the perceived network benefit from using the Banknet's services is greater than the transaction cost, they would switch from the Vietcombank's to the Banknet's services.

The learning cost can be illustrated by the launch of a new hardware device in personal computer technology. Although the new device runs more stably and efficiently than the old one, the introduction of such hardware might be annoying as it could lead to certain costs in the training of staff and even the purchase of new software (which is a transaction cost). In that case, even if PC manufacturers produce functionally identical machines, a consumer prefers to keep buying the original hardware from the same suppliers. Finally, artificial or contractual costs are demonstrated, for instance, in the cases of frequent flyers and loyalty customers. Once they have used the services up to a certain limit, they are switched to higher classes which enable them to benefit more from the service providers.The economic importance of switching costs is that the presence of these costs, especially with the two first types of switching costs, can lead to a monopoly profit for the suppliers, provided that the switching costs are greater then the anticipated benefits from the network effects. Under certain conditions, switching costs may cause the so-called 'excess inertia', which means users delay adopting a new technology or choosing from several technologies (Katz and Shapiro, 1985).

In addition, the existence of switching costs can also lead to 'excess momentum' - consumers rush to an inferior technology - for fear of becoming stranded. Excess momentum can also exist when there is a dominant firm that influences the standards in a network industry. In this case, the other smaller firms may be reluctant to apply a new technology because of the risk of being displaced by the dominant firm. This reluctance in adapting new technologies is apparently an obstacle for technical change. The existence of standards in this context is thus necessary for technological diffusion. The recent development of the wireless networking industry (so-called Wi-Fi) demonstrates the importance

of standards in promoting innovation. Before 1999, different vendors kept supplying their wireless equipment on the basis of their own standards. Users of Wi-Fi technology were consequently locked into different standards systems. When the six major firms in wireless technology, including 3Com, Nokia, Aironet, Intersil, Symbol and Lucent agreed on a common standard in 1999, the Wi-Fi market then expanded rapidly.

2.2 Minimum quality/safety standards

Customers can sometimes face a bewildering variety of different products and find it hard to assess which is suited for their purposes. Confusion of this sort can reduce the amount of trade taking place. In many cases, customers facing a large variety of substitute products may find it difficult to assess which products suit their needs and preferences most. This can even lead to a more substantial market failure, demonstrated by the so-called Gresham's Law in economics, which postulates that bad drives out good. Gresham's Law is reflected in the circumstances of the information asymmetries between buyers and sellers. Information asymmetry occurs because a producer has more information about the characteristics of the goods that he produces than his customers do. This may happen with any kind of goods, regardless of whether these are final goods or intermediate inputs necessary for another production process.

As shown by Akerlof (1970), the information asymmetry between buyers and sellers may significantly hamper the efficient functioning of markets, lead to adverse selection and severe market failures. If customers are not able to distinguish high-quality goods from other low-quality ones before buying, the supplier of the high-quality goods will find it difficult to sustain a price premium. In this case, he may not be able to survive if his cost exceeds that of the other competitors who sell low-quality products.

The low-quality sellers will then drive high-quality suppliers out of the market by undercutting them. Consequently, the market for both the producers and the customers of high-quality products will break down, meaning a severe market failure. The situation illustrated by Gresham's Law can be solved in the presence of minimum quality standards. If there are quality standards that are well-recognized by customers, buyers then have essential information to distinguish between high quality and low quality when considering whether to purchase. This is a necessary condition for the high-quality sellers to retain a price premium and thus stay in the market with their high-quality products.

The presence of minimum or quality discrimination standards also helps to reduce transaction costs and search costs. This is because standards provide information that defines the products, so buyers can feel more confident when making their buying decisions. In addition, they can also save time and money in evaluating different offers before buying. Such reductions in transaction and search costs are crucial for the development of large transactions in commodity

markets, in which traders must be able to buy and sell large-volume contracts without even viewing their goods. This is only possible if there is complete confidence in the characteristics of the products under consideration. Therefore, the presence of a clearly defined set of standards would be essential to minimize transaction costs for business activities. In addition, minimum quality or quality discrimination standards can also protect the third parties from negative externalities. Skea (1995), among others, postulates this benefit of safety standards by the case of environmental standards. With the increasing importance of environmental protection, governments around the world have defined several environmental standards, including maximum amounts of production, regulations on emission limits, and product safety standards specify requirements which aim at reducing the negative impacts for the environment generated during the production and consumption of the products. In addition to environmental standards, governments also adopt other policy tools such as environmental taxes, tradable emission permits. (A discussion of these policy measures is beyond the scope of this unit.)

Finally, it is also important to emphasize that the above functions of standards can only be realized in the presence of widely accepted minimum quality and/or safety standards. This calls for regulatory efforts in developing and enforcing these standards. In this regard, Salop and Sheffman (1983) introduce the concept of raising rivals' costs, which can be considered as a variant of the regulatory capture concept, used to imply the case when some producers may lobby the regulatory bodies to influence regulations in favour of their own interests at the expenses of others'. In fact, high-cost and high-quality producers are most likely to lobby for a high minimum quality standard, which will then serve as a market-access barrier to other competitors with lower costs and lower quality.

2.3 Variety-reducing standards

This type of standard limits the production of a certain product to a certain range of characteristics such as size, quality, and other technical specifications. In the real world, the majority of standards, regardless of whether they are formal or informal, perform this function of reducing variety. Such a function of standards as a variety reduction and/or focusing device can be viewed in two different ways: as either positive or negative economic impacts. Regarding the positive economic impacts, the function of variety reduction provides two main sources of benefits. First, it helps to obtain economies of scale by minimizing the wasteful resources invested in developing a series of minimally differentiated products and technologies to produce these products. As noted in Blind (2004, p. 20), focusing on just a limited number of models and/or technologies allow firms to perform (i) the mass sourcing of input materials; and (ii) mass production; and (iii) even achieve advantages via mass distribution. This is often considered as the best-known variety-reduction function of standards.

In addition to the variety-reduction function, standards also help to reduce the risks faced by suppliers in opting for technical innovation. In the infant stages of new technologies, the existence of standards can avoid wasted investment in different research directions by the pioneers. Otherwise, it is likely that the 'first movers' in some technologies may be locked into some pre-paradigmatic stages because there is no focus among suppliers on developing a market for the goods produced by their technologies. In this case, suppliers are stuck to small market segments defined by different and dispersed standards. It is then clear that the presence of variety-reducing standards is crucial for obtaining such a focus, and therefore for developing markets for new technologies.

However, there has long been an agreed trade-off between benefits induced by the function of variety reduction and its potential costs in terms of social welfare. While producers and suppliers may substantially benefit from reduction of variety, users may suffer from a utility loss due to a reducing range of choices and the increasing distance between their preferred specification and the supplied specification available in the market. In addition, the effectiveness of this function of standards may actually hamper innovation as there are a limited number of alternative technologies available for producers, which may be a direct result of technical standards on these technologies. This situation is likely to impose certain obstacles for innovation. In addition, reducing variety is also blamed for its potential anti-competition nature. Variety reduction enables economies of scale. It also leads to more capital-intensive production technologies and a smaller number of producers and/or suppliers. Although this does not necessarily reduce competition, it is reasonable to argue that it will progressively exclude small, potentially innovative firms from entry due to price-efficient and other technological thresholds established by the large producers in the industry.

2.4 Information/measurement standards

In the literature on standardization, information and/or measurement standards are considered as a distinct category from the other types of standards described above. But there are good reasons to consider this type of standards as a hybrid of the above three categories. A widely used example of measurement standards are grades of petrol, including four-star, unleaded, and super-unleaded, popularized by Swann (2000). As gas and petrol giants follow these grades, motorists are confident that all brands of four-star petrol are compatible with each another. Therefore, they can fill up with Total this month and Shell the next month without any problems. As a result, the petrol suppliers cannot only obtain economies of scale in mass production, but also in the distribution of their products.

Similar to information standards, measurement standards ensure that a product conforms to its description specifications. When a product carries the

measurement standards defined for it, it serves as a guarantee by the producer that the product to be sold is indeed what it is supposed to be. At the same time, consumers can buy that product in confidence without any costly attempt to evaluate the product. As a result, measurement standards provide a solution for overcoming information asymmetry between buyers and sellers as mentioned above. In addition, it also helps to reduce transaction costs and search costs, which are crucial for effective functioning of the market. In addition, information and measurement standards as inherent standards help provide evaluated scientific and engineering information in the form of publications, electronic databases, terminology, and test and measurement methods for describing, quantifying, and evaluating product attributes (Tassey, 2000, p. 4). Therefore, these standards are a common platform for technological changes. In addition, it may also provide certain basics in dispute settlement between the buyers and the sellers on the functioning of the products.

Economic impacts of different types of standards

	Positive impacts	Negative impacts
Compatibility / interface	- Network externalities - Increased variety of systems / products	- Anti-competition, leading to monopoly
Minimum quality / safety	- Solution for adverse selection - Reduced transaction costs, search costs - Prevention of negative externalities	- Regulatory capture: 'raising rival`s costs'
Variety reduction	- Economies of scale - Building focus and critical mass	- Reduced public choice - Leading to monopoly, market-access barriers
Information / measurement	- Increased trade - Reduced transactions costs - Facilitates commercialization of new technologies	

Figure: Economic impacts of different types of standards (Source: (modified) Swann (2000, p.8)

2.5 A case study from the mobile phone industry

This case study is reproduced from the WTO (2005, p. 38-39) to illustrate the benefit of standards, especially compatibility and/or interface standards (Official permission to reproduce the material for this case study has been granted by the WTO). Mobile communication networks have experienced dramatic growth over the past decade. In 2002, the number of cellular mobile subscribers around the world exceeded 1 billion, up from just 11 million in 1990. In 1990, mobile phone subscribers represented only 2 per cent of fixed telephone line subscribers, while by the end of 2002 there were more mobile cellular subscribers than subscribers to fixed telephone lines.
The creation of standards in the wireless telecommunication industry followed a different pattern in Europe and the United States. In the early 1980s, Ameritech installed the first analogue mobile phone system in the United States. The Federal Communication Commission (FCC) mandated the adoption of a single standard for the United States - the AMPS system (Advanced Mobile Phone Service). To avoid the emergence of a monopoly service provider, the FCC also imposed an antitrust regulation. The adoption of a unified, government-backed standard fuelled the growth of the network, and by 1993 more than half of the worldwide wireless cellular systems used this technology. By contrast, in Europe standards for first generation mobile phones differed across countries and were not compatible with each other. Two standards for first generation cellular phones competed in the European market: the Nordic Mobile Telephone (NMT) and the Total Access Communication System (TACS).

World Mobile Telecommunication by Type of Technology

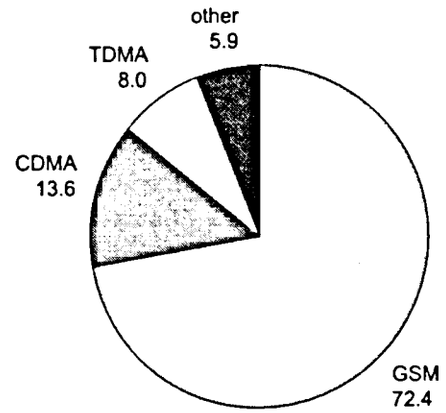


Figure: World mobile telecommunication by type of technology (Source: WTO 2005, p.39)

The former was developed by Nokia and Ericsson. It was first implemented in Sweden, and then spread to other Scandinavian countries. The latter standard was established in Italy and the United Kingdom. In this situation, not only was mobile communication equipment limited to operation within national boundaries, but there was also limited scope for exploiting economies of scale and forgone savings. The rate of diffusion of mobile phone communication (growth of the percentage of people using mobile phones) remained higher in the United States than in the EU during the whole of the 1980s.

In 1991, the second generation digital mobile phone was commercialized. The United States and the EU again chose different approaches to standardization. The FCC adopted a market-based approach. Several standards for digital mobile phones emerged in the United States market and they were left to compete for the dominant position in the market.

In contrast, in 1989 the European Telecommunication Standards Institute (ETSI) adopted a unified Global System for Mobile Communications, or GSM. This continent-wide standard for the digital network allows one cell phone to work across all European countries. The adoption of a single standard in Europe favoured the rapid diffusion of GSM technology in Europe, where analogue technologies (such as AMPS, TACS, NMT) were nearly completely displaced. The digital network grew very rapidly in Europe.

The number of users of the digital network for cellular communication rose in Europe from 4 per cent in 1992 to over 90 per cent in 1998. In North America, where the choice of the second generation technology was left to the market, there were a variety of technologies used, including AMPS, a first-generation technology. The growth of digital mobile phones suffered as a result. In the United States, they began to be used only in 1995, and in 1998 the percentage of mobile phone subscribers using digital cellular phones was still below 30 per cent. Harmonization of standards in the network industry in Europe allowed the rapid diffusion of the GSM technology across users, including outside European boundaries (see Figure 1 for an indication of the diffusion of the GSM technology as of 2003). By 1993, there were 36 GSM networks in 22 countries and over 1 million subscribers worldwide. At the end of 2003, over 400 GSM networks were operational in over 110 countries around the world and there were nearly 1 billion GSM subscribers, more than 70 per cent of the digital network. Standardization and diffusion of the GSM technology in the United States followed, but with a delay. In 2003, 20 per cent of North American mobile telecommunication used a GSM technology. The advantage is that now a European mobile user who travels to the United States can use his/her mobile phone to make a phone call in the United States (so-called international roaming).

In 2000, in an effort to consolidate existing incompatible mobile environments into a global network, the International Telecommunication Union (ITU) adopted a standard for third generation (3G) mobile phones: the International Mobile Telecommunication 2000 (IMT-2000). Two technologies were competing in the market to become the 3G global standards: Universal Mobile Telecommunication System (UMTS) and Code Division Multiplexing

Access (CDMA-2000). UMTS was supported by European and Japanese telecommunication firms. ETSI recommended that the ITU adopt this technology and a European decision in 1998 had mandated that 3G UMTS service cover 80 per cent of the population in Europe by 2005. The wireless communication company Qualcomm had endorsed CDMA-2000 as a 3G standard and protected this technology, entering into a patent dispute. Discord on a global standard retarded the commercialization of 3G mobile phones, which only just started at the end of 2004. The transition to the new technology will ensure compatibility with mobile phones from previous generations. In this way, switching costs will be minimized. Producers and consumers will benefit from economies of scale and network externalities.

2.6 Conclusion

In this chapter, we have investigated some essential economic concepts underlying the four different categories of standards. On the one hand, the standardization process facilitated by the recently rapid progresses in technologies has brought huge economic benefits to our economies and societies. Among others, standards help to realize potential benefits from network externalities and partially resolve the problem of information asymmetry by providing both buyers and sellers with better information on the products under consideration. In addition, the standardization process also enables economies of scale and mass production by reducing the variety of products and technologies. On the other hand, the presence of standards, especially the existence of what is termed a flood of regulations or legal jungle potentially hinders possible benefits from standardization. In this regard, standards may produce market-access barriers, reduce public choices, and exert considerable obstacles to innovation. As standards themselves can be neither inherently beneficial nor harmful to economic performance, there is a major role for governments, regulatory bodies and international organizations to play. Finally, it is also important to bear in mind that the economic concepts covered in this chapter will be frequently mentioned in the remaining chapters. This will provide learners with a more comprehensive explanation of the economic aspects of standards. It also implies that having a full understanding of this introductory chapter is crucial before proceeding with the other chapters of the unit.

3 Economic aspects of standards I: Technical changes and competition

This chapter explores the relationship between standards with two fundamental issues in economic literature and also the crucial drivers of economic performance: technical change and competition. This is one of the two main strands of economics literature on the impacts of standards on macroeconomic performance. The other strand focuses on the interrelation between standards and international trade, which will be the subject of Chapter 4. The analysis in Chapter 2 has suggested the two-sided nature in the economic impact of standards, which means that from a theoretical view it is not always likely that a consensus will be reached on whether standards have positive or negative impacts on certain areas. As such a consensus is not permitted, empirical evidence is called for. In this context, this chapter reviews the relationship between standards and technical change, and competition from both a theoretical background and empirical evidence which has recently become available. Section 3.1 explains the impacts of standards on technical change. Section 3.2 examines the relationship between standards and competition, and economic growth.

3.1 Standards and technical changes

There is a connection between standardization and technological change, which is crucial for economic growth. Technical changes are one of the fundamentals of economic performance and crucial for our economic prosperity. In the literature of development economics, endogenous growth theories have long attached an extremely important role in the development process to technical change. Investigating the impacts of standards on technical change is therefore essential to an understanding of the macroeconomic aspects of standardization.

3.1.1 Theoretical interrelation between standards and technical changes

Standards in general and especially technical standards exert influences on technical change in several, and sometimes contradictory ways. In principle, the existence of technical standards as a source of "public" knowledge that is widely accessible is taken for granted and is an important facilitator of technical change. It is, however, noticeable that technical changes driven by innovation are not enough for economic growth. New ideas and innovation from laboratories need to be successfully commercialized by the investors and then diffused to a wider public in order to trigger off significant and positive economic benefits. Diffusion of technologies can however be facilitated by a clearly defined

standards system. Therefore, the existence of standards can directly provide inputs for technical change, as well as the diffusion mechanism to ensure the realization of technical change in terms of economic benefits. The economics literature, however, also provides cases in which technical standards are likely to hinder technical change. This is especially the case when standards are firm-specific, which allows firms to operate such standards as a market-access barrier. In other words, standards can have either positive or negative impacts on technical change.

Positive impacts of standards on technical change

Economists have developed a number of theories to support the positive relationship between standards and technical change. Among others, this section focuses on the three following cases: first, standards and/or technical rules contain a rich content of technical knowledge, which is important to boost technological progress. As long as this information is non-proprietary standards, it is generally accessible to everybody, and provides a good basis, like patent documents, for researchers to generate innovations. As noted in Blind (2004), according to Bauer (1980), the existence of standards and/or technical rules is a crucial condition for a free know-how transfer within industries and among research communities. By these means, information flows and cost savings, which are fundamental to technical change, are generated. When this knowledge and these standards are accessible free of charge (or at low costs), they can facilitate technology diffusion either within or across countries. Even where standards are proprietary and protected by law, technical description of standards under registered patents may also provide useful starting points for technical adaptations by the others.

Second, in the global economy, most multinational corporations (MNC) are largely involved in assembling parts and components from various suppliers. In such circumstances, compatibility standards between different parts and components are essential. Business operation of MNCs can be described as a process of fragmenting the production chains into different blocks, which are then located in different countries according to their economics of location. In such a process of so-called fragmentation, which was popularized by geographical economists (see Krugman, 1991 for more details), standards are crucial in coordinating the activities between different blocks. In that sense, standards play an important role in minimizing the service link cost. Furthermore, standards are also a necessary condition for coordinating the pace and the adoption of technologies among producers of apparatuses, thus reinforcing technological diffusion either within or across industries and borders.

Third, as standards can incorporate a technical description of certain technology, the existence of standards is a means of internationally diffusing that technology. This makes important sense for the technological catch-up process of developing countries with modern technologies. Due to the widely recognized technological gap between the developed and developing countries, a mature technology which was developed and marketed in developed countries

is likely to represent technical advances for enterprises in developing countries. If firms in poor countries can opt for these technical advances represented in that technology, the standards can then provide an important means for the technological catch-up process in these countries. This is the essential idea underlying Vernon's life cycle theories and the neo-Schumpeterian approach in international trade (Winters, 1996).
Fourth, in the presence of the currently valid formal standards (for instance minimum quality standards and safety standards), as noted by Blind (2004), product and process innovations which satisfy these standards are facing a lesser market risk. This is because the consumers will trust and are willing to pay more for the products and processes that comply with the currently valid standards applied to these types of products and processes. As a result, the existence of clearly defined standards can provide an effective solution for the problem of information asymmetry (see Section 2.2 in Chapter 2 for more details).

Negative impacts of standards on technical change
However, there are also different arguments which oppose the positive impacts of standards on technical change and/or the driving forces of such change - innovations. The main argument that advocates negative impacts of standards on technical change has been essentially developed from the variety-reduction function of standards (as mentioned in Section 2.3 in Chapter 2). In addition, the existence of standards, which by nature create a certain level of inflexibility, and sometimes the effect of false standardization are likely to cause the phenomenon known as cementing the state of technology. With respect to the variety-reducing function of standards, if standards define the exact composition of a product regarding quality, form, interface, or other technical characteristics, the alternative product designs can only be produced with considerable additional costs of time and money. As noted by Blind (2004), the existence of standards questions a basic driving force of technical change: the existence of variety is a vital pre-condition for the selection possibilities in the market (Blind, 2004, p. 25).
Therefore, through the function of variety reduction, standards negatively influence technical change by preventing possible product variations which could provide a basis for the development of new products. In addition, as analysed in Section 2.3, in the presence of the variety-reducing standards, a limited number of firms who can afford the cost of obtaining economies of scale can develop their market power through expansion of their market shares. Consequently, small and innovative firms will be driven out of the market. In the conventional process of standardization, standards are firstly developed from the firm level, meaning that standards are, in many cases, company-specific. In this case, consumers will be more dependent on the enterprises that develop their company-specific standards. In the presence of company-specific standards, the company would offer a system with internally compatible components, and thus limit the exchange of single components to the component in

that system. This circumstance is essentially the same as the so-called lock-in effect of technical standards. As consumers are locked to certain company-specific standards, the switching cost to another system would be substantial. This further consolidates the existence of the company-specific standards in the form of a vicious cycle. As a result, company-specific standards also negatively influence the variety of products and/or technologies.
In addition, there are no guarantees that a set of standards would be the right standards, even in terms of technical performance. After all, the standardization process is under the control of technicians, regulators, or even bureaucrats who can make mistakes incidentally or deliberately (e.g. in the case when the development of standards is influenced by lobbying efforts of certain interest groups). In the presence of inflexible and even false standards, it is likely to end up with the cementing of the state of technologies, which results in reduced variations in the interest of standardization and the low incentives to change to other standards and/or technologies (Blind, 2004).
It is important to note there are cases and/or arguments in which these potentially negative impacts of standards on technical change can be counterbalanced. The variety-reducing function of standards and the increase in the combination possibilities of single elements enabled by interface and/or compatibility standards can bring in positive and considerable advantages of specialization. This also opens up the possibilities for mass production and distribution, leading to lower costs and thus more affordable prices, and enlarges the potential circle of customers. Furthermore, the problems of variety reduction can be minimized or even alleviated by standards that do not determine the exact content, designs, and technical specifications of the products/processes under consideration. In this regard, the problem of inflexible or false standards can also be resolved by performance-based standards that only define fundamental features of the products.

3.1.2 Empirical evidence on the impacts of standards on technical change

The above demonstration of the economic impacts of standards on technical change suggest that there is not an unambiguous answer to the question of whether standards have negative or positive impacts on technical change, and hence economic development. Under such circumstances, just like any other controversial area in economics, empirical evidence is needed. However, there is a relatively thin body of empirical studies on the impacts of standards and technical change. In principle, these impacts are subjects to the so-called chicken and egg phenomenon. It implies that the impacts between standards and technical change are likely to come from both sides. Therefore, we encounter the problem of endogeneity between technical change and standards. This problem practically clouds the causality between standards and technical change. In addition, as the impacts of standards have not been under debate

until recently, there are few sources of data available for empirical studies (see Blind, 2004 for more details). Therefore, measurement of technical change is seriously constrained by the problem of data availability.

In such a context, studies published by Blind and Grupp (1999), DIN (2002), Krechmer (2000), and Blind (2004), *inter alia*, are few existing examples. The most influential and comprehensive collections of reviews are found in Blind (2004). As noted by Blind (2004, p. 186), there are two central empirical issues related to the impacts of standards on technical change.

The first issue is about whether standardization activities follow the direction and speed of technical change. The second involves an investigation into whether the standards make technical change possible or hinder this change. In this chapter, we will focus on this second issue of empirical literature. The role of standards in encouraging technological diffusion and/or progress has been demonstrated empirically. In DIN (2002), technological change was assessed using the number of registered patents and the level of R&D spending as indicators, while standardization was assessed by the number of published standards and technical rules published by relevant authorities. It reports a significant correlation between the numbers of patent registrations and existing technical rules. In addition, more new standards are published in innovative sectors than in those which are less innovative. A similar correlation between R&D expenditure and the number of technical rules was also found. Similar to DIN (2002), Blind and Grupp (1999) examine the relationship between standardization as a proxy of the extent of technological diffusion and economic growth and technical change for Germany and report that half of the growth can be attributed to innovation, and a third is explained by technological diffusion and standards. On that basis, they argue that standards are a crucial part of innovation in Germany. In another study, Krechmer (2000) also reveals a positive effect of standards in codifying technical information and hence encouraging technology transfer. Blind (2004) also reports positive results regarding the relationship between standards and technical change. Using the sum of German patent applications as a proxy for technical change, he finds a significant and positive correlation between the sum of patent applications and the number of standards available. He goes further in examining the relationship between standards and technical change by applying more advanced econometric estimation techniques. Estimating various specifications of econometric models using German data in the period from 1973-1993 generally reveals that the development of patent application and R&D expenditures are important determinants of technical change.

Given the small number of existing empirical studies as mentioned earlier, the empirical evidence on negative impacts of standards on technical change is extremely limited. Blind (2004) recompiles the results from a survey of firms and identifies a number of factors that hamper innovation and hence technical change in German manufacturing industries. It is reported that (i) the lack of formal standards; (ii) the lack of information and technologies; (iii) the existing

industry standards; and (iv) the existing formal standards, among others, are considered to be obstacles to technical change. However, these standards-related obstacles hamper innovation less than other non-standards-related issues, including insufficient market information and human resources, organizational rigidities, lack of sufficient investment, and especially the presence of cumbersome administrative procedures and economic risk involved in the innovation process.

In conclusion, analysis of the impacts of standards on technical change - a fundamental factor of production in the macroeconomic performance of an economy - has shown that standards can exert influences on technical change in a complicated manner. Whether and to what extent standards lead to technical change may differ from one case to another. Generally speaking, standards are pro-effective for technical change. However, there are some cases, in which the existence of standards, especially those that are inflexible or even false can hamper innovation, and hence technical change. The interrelation between standards and technical change can be summarized in the figure below.

The impacts of standards and technical change

	Positive impacts	Negative impacts
Compatibility / interface	- More possibilities of combining system elements, forming network bridges	- Impending transition from old to new technology
Minimum quality / safety	- Reducing information asymmetries - Greater probability of market acceptance of new products	- Lock-in of technology status quo
Variety reduction	- Cost reduction, which fosters the accomplishment of critical masses of new products	- Reduction of variety
Information / measurement	- Information about the status of technology, source for new technological innovation (i.e. idea generation)	

Figure: The impacts of standards and technical change (Source: Blind (2004), p.28)

3.2 Standards and competition

This section explores the impacts of standards on competition, which is agreed by consensus as the main driving force of a market economy. By investigating the impacts of standards on competition, this section covers one of the most important macroeconomic aspects of standardization. As mentioned briefly at several points in Chapter 2 and in Section 3.1 of this chapter, standards exert certain influences on market structure. However, it does not appear clear whether standards are pro-competitive or anti-competitive. For instance, in Section 2.1, it has been argued that when direct and/or indirect network effects are perceived by customers, the wise supplier will generally produce a product that conforms to the industry standard, leading to a more competitive market. On the other hand, in the presence of switching costs leading to excess inertia or excess momentum, the standards possessed by the dominant firm are clearly a market-access barrier (Katz and Shapiro, 1985). In other words, standards can be both pro-competitive and anti-competitive.

3.2.1 Pro-competitive effects of standards

One of the most straightforward arguments of the pro-competitive effects of standards can be linked with the explanation of information and measurement standards given in Section 2.3 in Chapter 2. These arguments can also be linked to the impacts of standards on technical change. As mentioned in Section 3.1, standards and/or technical rules contain a rich content of technical knowledge and can be considered as a source of public knowledge. As long as this knowledge is accessible, standards provide a channel of information flow and cost saving which tends to level the playing field among rivals. In addition, the production and publication of interface specifications that are non-proprietary also tends to restrict the chances of using the supplier's proprietary technology and other non-proprietary components to exploit the monopoly power. In this regard, the existence of standards reduces the unequal starting position for new entrants to the market. It has also been mentioned in Section 3.1 of Chapter 2 that compatibility and/or interface standards help to remove entry barriers in markets for network products and services. This is because in the presence of stan-dards, companies do not have to invest heavily in capital facilities and R&D for producing integrated systems. Instead, integrated and complete systems can be formulated through an alliance of different suppliers, providing that there are sets of standards which define the content, designs, and technical features of single components in the system. This case makes market entry easier even for small and innovative firms. In addition, it also further facilitates price competition as more and more component suppliers enter the market for the network products and services. In markets for complex products, where conformity with a performance standard for the integrated system is not transparent to the customers, the certification of compatibility accredited by independent testing institutions presents an aspect of quality competition, which is beneficial for the consumers.

Farrell and Saloner (1992) argue that the production and/or publication of compatibility standards by means of converters and gateway technologies that make use of information about sub-system interfaces reduce the incentives of a supplier to create switching costs for their customers. These also prevent them from extracting the rent on the purchase of replacement components by the customers who have decided to choose their supplier. When switching costs are low, it is more likely for the customers to "switch" to other systems, even in network industries, leading to more competitive pressure on the rivals in the industries under consideration. Finally, as noted by Blind (2004), the presence of compatibility standards is evidence of a requirement or institutional pre-condition for effective deregulation of network industries that were previously influenced by natural monopolies or by some state-imposed monopolies in the hands of certain state-owned enterprises. In this regard, technical compatibility standards are critical for restructuring the network industries towards a more decentralized organizational structure, where a large number of suppliers compete for the provision of components and services. This obviously leads to more a competitive market structure.

3.2.2 Anti-competitive effects of standards

As mentioned at several points earlier, standards exert an anti-competitive effect on market structure when only a small number of firms control the specification of standards, and thus are able to internalize the benefits of standardization. Especially when property rights on technological specification are leveraged by proprietary standards, it will seriously worsen market competition. According to David and Steinmueller (1994) and Tassey (2000), standards are anti-competitive in the following ways. In some cases, the negative impacts of standards on competition are caused by different endowment levels among firms. It is obvious that firms differ in the type and value of their resources. Some firms may possess more superior resources which allow them to control or at least influence the standardization process better than the others. Even when a consensus can be obtained by important stakeholders, the dominant firms are still likely to manipulate the outcome of the standardization process at the expense of the other smaller firms. In markets for network products and services, if some firms are successful in building up large networks of customers, it enables them to take advantage of economies of scale from mass production and even mass distribution). The presence of economies of scale allows these firms to impose a market-access barrier on potential entrants because their low costs and hence prices obtained from mass production distribution can be considered as entry thresholds.

In addition, as noted in Klemperer (1987), when network externalities are significant, these tend to foster the demand for network products and services.

The firms with the expectation of becoming leaders in the market for those products and services may reduce their prices in the short run, not just on the basis on the sales volume they expect to take but also on the volumes caused by market growth. When this pricing strategy is employed, the firms will keep out potential entrants and establish a monopoly position. The two cases above explain the anti-competitive effects of standards as a result of the response of individual firms upon the potential benefits they would gain from controlling or influencing the standardization process. In fact, the anti-competitive effects of standards can also be the result of collective actions between groups of individual firms. Salop and Scheffman (1983) postulate that strategic alliances of producers can use the formal standards writing process to publish product specifications that impose considerable costs upon current rivals outside their coalition. They may even go further to prevent possible future competition by issuing anticipatory standards that influence technical change towards areas where they have control of complementary or basic technologies through intel-

The computer industry itself and upstream market segments of producing integrated circuits and memory devices have been recently expanded as responses to new technological opportunities which were made possible through rapid technological progress in electronics. Two new segments in this high-tech industry built around CPUs and independent individual computing, microcomputers and workstations were based on a breakthrough technical advance, microprocessors. Standards in these two new segments have different impacts on competition.

Some first microcomputer platforms were developed in the early 1970s. The standards in this segment were defined by the size, the speed of CPUs, and especially the type of users, named as 'hobbyists', who could assemble and program their own machines.

Within this segment, competition with microcomputers was avoided as microcomputers were far smaller and cheaper than minis. In addition, costs of complex distribution and support structure were also minimized. As a result, diffusion and sales of these microcomputers depended on sharing technical informatioon within hobbyist communities. This period witnessed very rapid technical changes but not concerted market efforts.

After many precursors arose in the microcomputer industry during the 1970s, the sales of workstations started increasing rapidly in the mid-1980s. In this segment, the impact of standards on competition are reflected in a different pattern. There computers were developed and sold by entrepreneurial firms with services and support similar to the suppliers of microcomputers. However, the standards were largely influenced by users, who were engineers and technical staff. These workstations were marketed not as complements but as substitutes for microcomputers. The 'diskless' workstations would be networked to microcomputers, which would store the user's 'programmes' and data on the latter's disks. In this way, the providers of these workstation avoided direct competition with the other established platforms and set their own standards.

Figure: Standards and competition in microcomputing (Source: modified from Bresnahan & Greenstein (1999))

lectual property rights, or cost advantages based on already realized learning effects. As shown by David and Steinmueller (1994), regulatory bodies or standards development organizations that publish standards are likely to be vulnerable to "capture" by large domestic producer interests as the latter possess the technical expertise necessary to specify standards.
In an extreme case, the government may pursue the pick-the-champion strategy in order to set standards in favour of domestic producers, at the expense of foreign competitors. In this case, the existence of standards plays the same role as non-tariff barriers to trade. This is especially the case for technical barriers to trade, which is one of the main subjects in Chapter 4. Interestingly, government bodies can also facilitate certain anti-competitive effects of standards by their procurement standards. Through large contracts with certain specifications of the products and services, government bodies and large clients in general may favour a small number of existing large producers who are supposed to have sufficient resources to assure the supply in compliance with their clients' specifications.

These standards can be then dominate the markets, even though their technical characteristics may not fit the needs of other users. An example for this case pointed out by David and Steinmueller (1994) is the telecommunications industry, where infrastructure is purchased by a state-owned monopoly and the private users have to buy compatible telephones although they may have other preferences (it is however important to note that since then the telecommunications industry has been liberalized in many countries, leading to the reduction of state-owned monopolies).
In conclusion, it is important to bear in mind that both pro-competitive and anti-competitive effects of standards can be generated at the same time by one single standardization activity and its output (i.e. the publication of standards). These contradicting effects on competition can work simultaneously in the same market. In addition, these effects of standards on market structure also vary across the life cycle of the products or processes under consideration. Moreover, the development standards are likely to exert different types and degrees of impact on competition at different development stages of the industry and the maturity of its technology. In other words, the impacts of standards on competitive market structure are influenced by the dynamics and speed of technical change. In such circumstances, there is no single answer to the question as to whether standardization facilitates or hampers market competition.

4 Economic aspects of standards II: Standards and international trade

The impacts of standards in the context of international trade have become one of the most controversial debates among trade economists in the recent decade. On the one hand, it is logical to extend the pro-competitive effects of standards on competition towards international market structures. In this regard, standards exert positive influence on transactions of goods and services across borders. On the other hand, the existence of national technical standards, for instance, can be also considered a variant of non-tariff barriers which effectively hinder international market penetration, and hence international trade flows. In this context, this chapter covers the second strand of economic literature on the impacts of standards and investigates the roles of standards in international trade. Section 4.1 reviews major arguments on the pro-active role of standards in facilitating international trade. Section 4.2 follows with criticism which is mainly founded on the potentially negative effects of standards as technical barriers to trade. Some important issues of standardization under globalization will be explored in Section 4.3. Finally, a case study on international air transport services is introduced to reinforce the analysis covered in this chapter.

4.1 Pro-active effects of standards on international trade

4.1.1 Standardization facilitates expansion of the international market and reduces international market entry costs

In the context of international trade, firms operate their activities under the co-existence of different types of standards, including government-imposed standards, industry-specific standards, and other voluntary standards promoted by other stakeholders. Even when standards are not regulatory, it is for the benefits of firms to conform to the standards in the host country for market penetration. As shown by Gandal and Shy (2001), when network externalities are substantial, countries (and industries) have incentives to harmonize their standards across borders (and industries) in ways that make their products large or even identically compatible. Such movements towards harmonization of standards then reinforce international trade flows. In the presence of global network externalities, the existence of internationally recognized standards serves as a necessary condition for international trade in these products and/or services. In addition, the existence of agreed standards in industries that are global in scope also reduces the cost of entry to foreign markets. The market for telecommunication equipment, personal computers, electronics, and automobiles are typical examples of the competition-enhancing effects of standards. Without agreed standards and/or technical rules, it would be very costly for those who plan to penetrate foreign markets, where the host's domestic standards are not compatible with their technologies.

4.1.2 Standardization promotes international trade in intermediate inputs

The production and distribution of products and services have recently become more and more international. MNCs have strong incentives to divide their production and distribution chains into different blocks to be located in different locations. The location decisions are determined by the comparative advantages of each location. Under this so-called defragmentation process of production in international markets, there are firms that assemble completed products from different parts and components, which are produced in different countries. One hundred years ago, all the parts to assemble a General Motors car were produced in the United States. At present, there are only a few domestically produced components used in the assembly. Instead, components are made in different parts of the world and exported to the US for assembly. In this context, the existence of standards is crucial for ensuring the compatibility of components and parts from a host of suppliers. As a result, internationally accepted standards promote trade flows in intermediate inputs, which have been long agreed as the most important single source of international trade under the umbrella of the so-called 'intra-industry' trade. Moreover, standards also help MNCs to substantially reduce their costs of production because inputs can be used in the production process without any further processing. More importantly, inputs can be imported at lower prices than domestically produced ones because foreign inputs are produced in locations with comparative advantages in production. Similarly, standards are also necessary for co-ordinating the adoption of innovation and ensuring cooperation among different suppliers of parts and components in markets that trade in the same apparatus for the final products. In this way, international mutual standards can reinforce technology transfer across borders. In addition, the existence of standards allows firms or affiliates within an MNC to specialize in a certain segment of the production and distribution chains, and is thus essential for obtaining economies of scale in production and distribution.

4.1.3 Standardization provides a solution for information asymmetry in international markets

There is no limiting value for information asymmetry. In the case of information asymmetries, it is likely that markets, alone without any intervention, may undersupply certain goods and services. It may even push high-quality producers out of a certain market. Due to Graesham's law, as explained in Chapter 2, when consumers have little information about the product they want to buy,

they are then unable to distinguish between high-quality and low-quality sellers. As a result, the market may end up with an undersupply of the high-quality goods. In the worst case, the high-quality suppliers may even be driven out of the market. Let us focus on agricultural products, which are the main export items of developing countries. One example of information asymmetry in the international marketplace is the trade in meat products. The safety of meat produced in the exporting country depends on how the cattle were raised. The production of 'safe' meat is more costly than other low-quality meats as it requires certain machines, inputs, and/or the application of advanced livestock raising techniques. If consumers in the importing countries are unlikely to distinguish between 'safe' meat and other low-quality meat, they will generally buy the cheap and low-quality meat, causing the market for 'safe' meat to collapse. Consequently, the importing market may drive the 'safe' meat producers out of the market. As the same outcome can be observed for most other agricultural products exported from developing countries, it is clear that information asymmetry in an international market is an obstacle for agricultural exports. In this context, the existence of standards, especially minimum quality/safety standards is important to facilitate international trade as it prevents products that do not match the standards from undercutting other products that satisfy the standards required (and are thus generally more expensive and of higher quality). In the case of voluntary standards, low-quality sellers are not ruled out of the market. However, the presence of such standards may still ensure that high-quality products are not driven out by lower-quality offers. As it is still possible for lower quality products to enter the market, voluntary standards are often considered as more "market-friendly" than regulatory ones. In other words, voluntary standards can partially resolve the information asymmetry problem. But if standards are mandatory, it will provide an absolute solution for such an information asymmetry problem. In both the two cases, the presence of standards would provide an important guarantee for greater international trade flows.

4.2 Negative effects of standards on international trade

4.2.1 Although network externalities provide incentives for market-expansion, there are no guarantees

It is argued that compatibility standards increase trade; there are, however, no guarantees. Although strong network externalities can expand international markets, they may also be a source of market power. In a number of international marketplaces where the standards developed by some firms are adopted as *de facto* industry standards, these dominant firms would then have substantial advantages over the other market followers. When these *de facto* standards provide market power for the dominant firms, these standards are an impediment

to free trade, and thus to market penetration. As noted in Section 4.1.1, the existence of global network externalities provides incentives for countries and/or industries to harmonize their own standards to ensure the necessary level of compatibility that is considered essential for international trade flows. However, such outcomes cannot be taken for granted. Such harmonization requires international coordination among the relevant stakeholders. In the context of the domestic market, coordination problems such as excess inertia or excess momentum can be resolved more easily than in the context of international markets. As the relevant stakeholders come from different countries, it is likely that the winners in such harmonization process can gain substantial advantages from the adoption of their standards at the expense of the losers, who are smaller and less competitive than the winners. Therefore, the harmonization process risks conveying market power to the dominant firms.

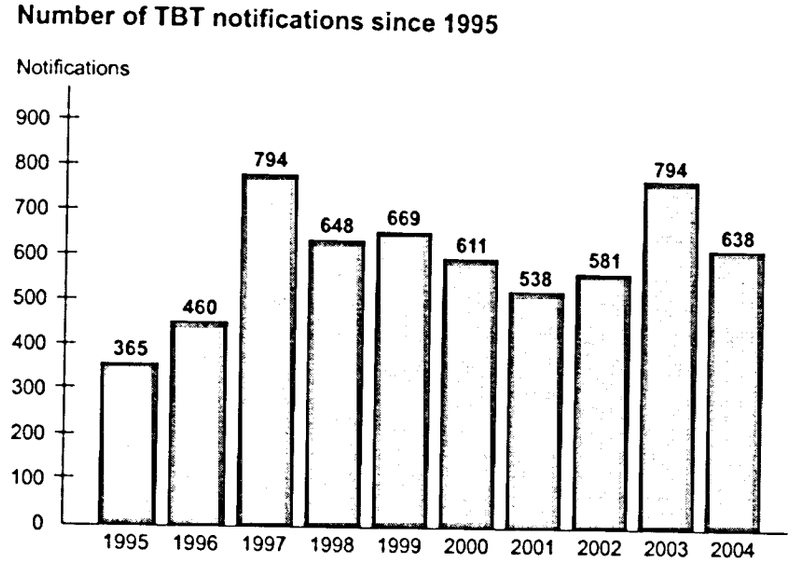


Figure: Number of TBT notifications since 1995 (Source: WTO 2005, p.39)

4.2.2 Standards can play a role as a protectionist device

The use of mandatory standards in developed countries has long been criticized by the developing world as a considerable technical barrier to market penetration. Although governments may introduce standards as a solution to information asymmetry, as analysed earlier, such introduction may have possible adverse effects on trade. In practice, governments may be more influenced by

the interests and/or lobby efforts of domestic firms when developing national standards. It is not unlikely that standards will be developed in a manner that gives domestic firms certain competitive advantages over the potential foreign competitors. In this case, mandatory standards act as protectionist devices. In other words, if the standards are set arbitrarily, they could be used as an excuse for protectionism; standards can then become obstacles to trade.
More generally speaking, technical regulations and standards can be largely considered as technical barriers to trade. There are many reasons leading to the existence of TBT in a range of areas, such as health, safety, environmental and consumer protection issues. These requirements can be imposed by both governments (mandatory standards) and non-governmental organisations (voluntary barriers, standards). In the presence of such technical rules, exporters will have to alter their products in order to comply with differing partner country requirements. Therefore, technical barriers to trade raise the cost for exporters. In the case of developing countries, as their technical capacities to match developed economies' technical requirements are limited, such barriers may then become market entry impediments.

4.2.3 Environmental concerns and international trade

One important area where governments around the world have increased regulatory activity in recent decades is that of environmental issues. Environmental externalities are considered as a severe market failure. They appear because the users of environmental resources do not internalize the costs of environmental degradation caused by their production. In this case, the private marginal cost of the producers from producing an additional unit of product is smaller than the social marginal cost, which includes that private marginal cost and the cost of environmental pollution. Therefore, the market itself will end up with oversupplying the products at the expense of environmental degradation. This market failure justifies government intervention. In practice, authorities have used taxes or charges to force firms to internalize these pollution costs, together with environmental standards to control pollution (see Bovenberg and Goulder, 2001 for instance). Facing environmental standards imposed by importing countries, exporters have to produce their products in such ways that comply with the environmental rules in destination countries. Whether such modification to their production process reduces the trade flows is a controversial issue. On the one hand, such modification is costly, and sometimes beyond the technical capacity of exporters in poor countries. In this case, environmental issues exert a negative impact on trade. On the other hand, one might argue a win-win scenario, in which companies who have modified their production process in compliance with environmental regulations would improve their competitiveness. As a result, their export volume will rise after a short period of transition. However, a win-win scenario is not always observed in reality. In many cases,

the presence of environmental regulations, as a type of technical barrier to trade, impedes international trade flows.

4.3 Standardization for globalization

As analyzed in Section 4.3, if standards are set arbitrarily, they could be used as an excuse for protectionism and can then become a considerable impediment to international trade. If individual governments work on their own without any international coordination mechanisms and/or constraints, it is likely that they will create an artificial comparative advantage for domestic producers. Therefore, standards may be used as an implicit or 'hidden' protectionist device like other technical barriers to trade. Such a scenario is obviously not desirable for the main actors of globalization. As a result, several coordination efforts have been undertaken to avoid possible trade conflicts and/or obstacles that standards may bring in. This section explores the issues of standardization within the WTO's agreements. So far, we should be familiar with the ideas that standards

Total number of standards published and the number of international standard adopted by national standard bodies (31/12/2002), by region

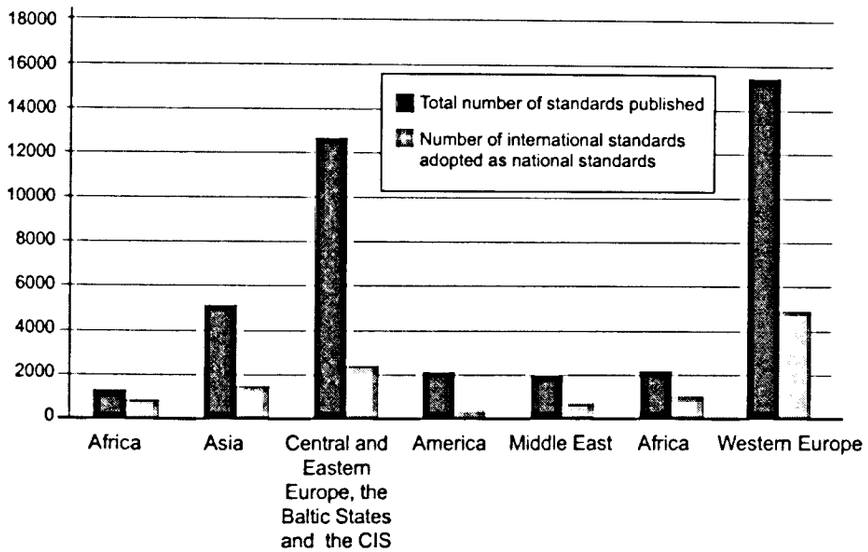


Figure: Total number of standards published and the number of international standards adopted by national standard bodies (31/12/2002), by region (Source: ISO Members Directory 2003)

that are set at the national level are not only important to facilitate transactions within national borders, but also affect outcomes of international transactions. If national standards are in compliance with international standards, the presence of standard uniformity would enhance international trade flows. Within the WTO framework, the two main agreements on standards - the TBT Agreement, and the SPS Agreement - were developed to minimize the possibilities that the member countries might use their national standards in such a manner as to constitute a technical barrier to trade.

As these issues have been explained in the unit on International Standardization, this section only briefly reviews these two main agreements. The TBT Agreement covers the main technical regulations, standards and conformity assessment that are compulsory for the member countries. Article 2, in particular, states a set of main principles for the preparation, adoption and application of technical regulations by government bodies of the members. As regulated by the TBT Agreement, most of the principles applied to technical regulations also apply to voluntary standards. This issue is covered by the Code of Good Practice for the Preparation, Adoption and Application of Standards. The procedures to be followed for conformity assessment by government bodies of the member states are regulated in Article 5, which is accessible at the above web links.

As noted in the WTO (2005, p.130), "the TBT Agreement applies to a wide range of bodies and systems, local, national, regional and international, governmental and non-governmental. Rights and obligations under the TBT Agreement vary depending on the type of body concerned. The TBT Agreement recognizes that governments employ technical regulations to attain legitimate objectives such as national security requirements, the prevention of deceptive practices, protection of human health or safety, animal or plant life or health, or the environment. But technical regulations must not be prepared, adopted or applied with a view to, or have the effect of, creating unnecessary obstacles to international trade. So technical regulations should not be more trade-restrictive than necessary to fulfil a government's legitimate objectives."

In addition to the TBT Agreement, the WTO member countries have signed the SPS Agreement which regulates sanitary and phytosanitary standards. The SPS covers any measures applied to protect human, animal and plant life or health within the territory of member countries from risks arising from the entry, establishment or spread of pests, diseases, additives, contaminants, toxins or disease-causing organisms in foods, beverages or feedstuffs; diseases carried by animals, plants or products thereof, or from the entry, establishment or spread of pests (for full details see the SPS Agreement).

Under the SPS Agreement, the member countries are required to harmonize their sanitary and phytosanitary measures to prevent the 'unjustifiable' use of these measures as discrimination among members themselves or as protectionist devices. According to WTO (2005, p.133), "members are to base their sanitary or phytosanitary measures on international standards, guidelines or recommendations, where they exist. As international standards will not exist

in all cases, the WTO members may still adopt different SPS measures. However, they must ensure that their measures are based on an assessment of the risks to health. Furthermore, the SPS Agreement requires members to accept the sanitary and phytosanitary measures of others as equivalent to their own if the exporting country demonstrates to the importing country that its measures achieve the importing country's appropriate level of SPS protection."

4.4 Bilateral or multilateral arrangements in standardization: The case of the air transport industry

This case has been developed from the materials presented in WTO (2005, p. 213-252), entitled International Trade in Air Transport: Recent Developments and Policy Issues. Official permission to reproduce some parts of these materials has been given by the WTO. Air transport, like other transport services, is associated with international trade in two distinct ways. First, air transport is traded as a service in its own right. Second, it is a key intermediate service for many other kinds of trade, in the domain of both goods and services (such as tourism). Numerous studies have highlighted the importance of an efficient, effective and reliable air transport infrastructure, especially in developing countries, to ensure the materialization of the gains from trade (WTO, 2004). This importance is expected to increase as a result of technological innovation, deregulation and enhanced market access for foreign companies, which are all making air transport more accessible to a wider set of customers in a broader range of countries. The purpose of this case study, which is largely developed from the World Trade Report 2005, is to review the importance of the air transport industry in international trade, and to analyze the debate on whether or not multinational rules on market access in international air transport would make a significant contribution to efficient functioning of the trading system.

4.4.1 Air transport and international trade

Overview of the air transport industry

The performance of the air transport industry depends on a large number of the same factors that determine the economic performance of a national economy, such as GDP growth, growth of exports and imports (both commodities and services), sectoral growth rates of the related industries. In fact, the growth of the air transport industry is positively correlated with the economic growth rate. Figure 4 shows an increasing volume of air transport output, measured by tonne kilometres performed (TKPs). Meanwhile the real yield has been declining as revenues over expenses have been stable. In Table 4, the growth in international output, measured in terms of either passengers or volume was

impressive in the 90s. One explanation for this feature is the number of structural and regulatory changes that occurred during that decade. These included the combined effects of deregulation and liberalization in some major countries and the introduction of new forms of business. The impressive growth of international air transport has been made possible by new technological changes which enabled airlines to lower the cost of air travel and increase its accessibility to a wider set of consumers. This has been achieved through two mechanisms. Firstly, through more fuel-efficient and otherwise cost-effective aircraft. Second, by changing the composition of the fleet. A broader choice of aircraft types has made it easier for airlines to penetrate different international markets. Technological developments have not been limited to the speed, range and capacity of aircraft. In recent years, one of the most influential technological developments in the industry has been the strengthening of business-to-customer links through the Internet, which help to expand the customer base for airlines. Investing in the air transport industry requires a huge fixed cost for infrastructure and assets. This explains the reason why certain pairs of destinations are served. As a firm has to invest in capacity in order to provide a service, it will do so only in markets or city pairs where there is a sufficient market. Figure 5 shows a stylized expense structure of airlines, in which flight operations, including the cost of aircraft and running expenses are approximately 45 per cent of total costs. The existence of large fixed costs may act as a deterrent to entry, reducing the number of operating firms that would otherwise be in the market.

International outputs of scheduled airlines, 1991-2000

	Passengers carried		Passenger-kilometres		Freight tonnes carried		Freight-tonne kilomtres		Total tonne-kilometres	
	Millions	Share of total (per cent)	Millions	Share of total (per cent)	Millions	Share of total (per cent)	Millions	Share of total (per cent)	Millions	Share of total (per cent)
1991	266	23.4	861530	46.7	8.5	48.6	46410	79.3	128280	55.6
1992	299	26.1	982490	50.9	9.3	52.8	50750	81.0	143600	59.3
1993	319	27.9	1047380	53.7	10.3	56.9	56050	81.9	155490	62.0
1994	347	28.1	1143180	54.4	11.8	57.6	64700	83.8	173080	63.3
1995	375	28.8	1249160	55.6	13.0	58.6	70340	84.6	189430	64.4
1996	412	29.6	1380680	56.8	13.6	58.6	75510	84.7	206870	65.2
1997	438	30.1	1468150	57.1	15.7	59.5	87740	85.3	227390	66.1
1998	458	31.1	1512040	57.5	15.8	59.6	87050	85.5	231440	66.4
1999	493	31.6	1622250	58.0	17.3	61.6	93280	85.8	247610	66.8
2000	538	32.5	1778110	58.9	18.8	62.3	101520	86.1	271400	67.7
2001	532	32.8	1715740	58.6	18.0	62.9	95950	86.7	259520	67.3
2002	545	33.7	1732160	58.9	19.0	64.4	100590	86.2	265650	67.8

Figure: International outputs of scheduled airlines, 1991-2000 (Source: WTO 2005, p. 215)

Air transport industry and international trade

Air transport can have direct and indirect impacts on international trade. For direct impact, suppliers in the air transport industry provide a wide range of goods and services, involving the carriage of passengers, the movement of goods (freight), rentals (charters) of carriers with crew, and related supporting and auxiliary services. The conventional approach classifies air transport services into three types (i) movement of passengers, (ii) freight, and (iii) other transactions. The indirect impact of air transport is captured in two ways. The first is through expenditure by non-residents on goods and services purchased in a foreign economy. This component, which is most commonly associated with tourism, can be facilitated through air transport, or other modes of travel. The second is through expenditure on goods related to the air transport industry, but not directly linked to the movement of persons. Data on both direct and indirect impacts of air transport on international trade is given in Table 5. It becomes clear that, on average, air transport can account for approximately 10 per cent of total world trade in services. For some developing countries, such as Pakistan, air transport accounts for as much as 43 per cent of services exports.

It is also important to note that the economic importance of air transport is not only present in countries with developed air transport industries. In this context of small developing countries, although their air transport capacities may be limited, air transport is still extremely important to them as a means by which they can export their tourism services and their products. It is a fact that in 2000 half of the total international arrivals for tourists in Africa arrived by air. The equivalent figure for Latin America and the Caribbean is 55 per cent (WTO, 2005, p. 219-220).

4.4.2 Market access in international air transport

International air transport and Open Skies arrangements

Market access in international air transport is a complicated concept, defined by a number of variables, including the designation of carriers, the entry of these carriers on specific routes and the flexibility to establish capacity and prices on routes. As a starting point, the industry has defined eight different types of international air traffic, which it has called freedoms. These range from the first freedom to overfly another country to the right to carry freight and passengers on domestic routes in a foreign country. The freedoms have evolved from the basic sovereign right possessed by every country to regulate air traffic within its borders. Exercise of this right means that national governments have the right to decide which carriers have access to the various freedoms and in which manner. Market access in international air transport has been largely shaped by Open Skies agreements. Open Skies agreements can be considered as major bilateral initiatives toward liberalization of international air transport. The main principles of such agreements are expressed below. By 2002, the United States

	Passenger		Freight		Other		Total	Air transport as percentage of total commercial services trade
	Dollars (Millions)	percentage of total	Dollars (Millions)	percentage of total	Dollars (Millions)	percentage of total		
Exports								
Extra-EU (15)	18967	63	4280	14	6639	22	29894	10
USA	16291	74	5787	26	n.a.	n.a.	22078	8
Japan	2561	33	2287	29	3018	38	7867	12
Canada	2021	64	n.a.	n.a.	1145	36	3165	8
Russia	1142	53	486	22	534	25	2161	16
Taipei, Chinese	486	26	1306	70	78	4	1870	9
China	1114	67	539	33	n.a.	n.a.	1653	4
Malaysia	966	81	163	14	69	6	1198	8
Mexico	689	68	n.a.	n.a.	327	32	1016	8
Pakistan	465	72	50	8	128	20	643	43
Israel	281	54	127	24	114	22	522	5
Imports								
Extra-EU (15)	14066	54	3046	12	9095	35	26147	9
USA	19189	80	4878	20	n.a.	n.a.	24067	11
Japan	8309	74	1994	18	962	9	11265	11
Canada	2398	64	1352	36	n.a.	n.a.	3749	8
China	1308	37	2190	63	n.a.	n.a.	3498	8
Taipei, Chinese	1224	59	262	13	591	28	2077	9
Mexico	1027	52	270	14	676	34	1973	12
Russia	271	22	559	45	401	33	1230	5
Israel	773	64	83	7	345	29	1201	11
Malaysia	712	74	n.a.	n.a.	249	26	961	6
Argentina	388	67	74	13	113	20	575	13

Figure: Air transport as percentage of total trade in services (Source: WTO (2005, p.218)

had signed 59 Open Skies bilateral agreements. In a similar effort to the United States, countries have signed several Open Skies arrangements with different types of freedoms to liberalize market access for international air transport. In addition to bilateral arrangements, a number of regional agreements have recently been signed. A notable aspect of the information in the table is the number of agreements among developing countries.



GATS and market access in international air transport

The existence of bilateral and plurilateral arrangements toward liberalization of international air transport is likely to lead to a kind of spaghetti bowl as market access in the industry is governed by a large number of arrangements. This calls for international coordination to facilitate opening skies around the world. At the moment, we are still in the middle of the process as the WTO's General Agreement on Trade in Services (GATS) excludes the core of commercial air transport - the hard rights or traffic rights and the services directly related to the exercise of traffic rights - from the scope of GATS. Nevertheless, members decided that GATS shall apply to measures affecting three services relevant to air transport - namely: (a) aircraft repair and maintenance services; (b) the selling and marketing of air transport services; and (c) computer reservation system (CRS) services. Since GATS became effective in January 1995, the accessions of new members have only marginally changed the picture. In addition, the members have also agreed on a grandfathering provision, whereby

any specific commitment or obligation assumed under GATS shall not reduce or affect a Member's obligations under bilateral or multilateral agreements that are in effect on the date of entry into force of the WTO Agreements. Under such circumstances, it is not surprising that the question of the coverage of air transport services by GATS has been the subject of many controversies.
According to WTO (2005, p. 250), the focuses of this debate have been concentrated on the following:

- Paragraph 1 of the Annex on Air Transport Services (which has the same legal value as the GATS agreement itself), stipulates that the Annex applies to measures affecting trade in air transport services, whether scheduled or non-scheduled, and ancillary services. While measures affecting trade in services" have been widely defined by subsequent dispute settlement cases, trade in air transport services is not defined and nor are ancillary services;
- Paragraph 2 of the Annex stipulates that the Agreement, including its dispute settlement procedures, shall not apply to measures affecting: (a) traffic rights, however granted; or (b) services directly related to the exercise of traffic rights. While traffic rights are extensively and precisely defined by the Annex, services directly related to the exercise of traffic rights have not been defined at all.

The divergence of views among Members on approaches to the coverage of air transport services by GATS arises from this absence of definitions. The problem is further complicated by the absence of a clear distinction between the general exclusion (traffic rights and services directly related to the exercise of traffic rights) and the exception to that exclusion (the three covered services), as well as by the lack of any link between the classification of the Annex and the classification generally used for all other services. There have been some efforts towards further clarifications and wider coverage of air transport services within GATS. Paragraph 5 of the Annex, the review clause, states that The Council for Trade in Services shall review periodically, and at least every five years, developments in the air transport sector and the operation of this Annex with a view to considering the possible further application of the Agreement in this sector. There were four meetings of the Council on Trade in Services between Sept 2000 and Nov 2003, with intensive debates on the coverage of air transport services by GATS without any consensus. In the absence of a definition of what constitutes a service directly related to the exercise of traffic rights, several Members contended that since the Annex only excluded the services directly related to the exercise of traffic rights, services not directly related to the exercise of traffic rights were already included in the scope of GATS. These members suggested that services such as catering, leasing, ground handling, airport management services, and freight forwarding services for air transport were not related to the exercise of traffic rights and therefore already covered by GATS. This is the so-called grey area. These Members therefore called for commitments in such areas as ground handling services and airport management services in the context of the Doha negotiations. On the other hand,

there was no space for a grey area, since the three covered sectors were an exception to the general exclusion of traffic rights and of services directly related to the exercise of traffic rights. Some members opposed any extension of the scope of GATS on the grounds that the rationale of its existing scope had not changed and that liberalization was occurring anyway in a bilateral, regional and plurilateral context. Thus, they argued, multilateral liberalization would act as a brake on the ongoing autonomous process of liberalization (i.e. the process of negotiating Open Skies arrangements). Furthermore, some members also proposed that ICAO is a more proper forum to discuss these questions. By and large, multilateral liberalization in international air transport has still been in an intensive negotiation process. At the moment, the only agreed conclusion among the WTO members was to decide that the formal commencement of the second review (would) take place at the last regular meeting of the Council for Trade in Services of 2005 prejudge Members' interpretation of paragraph 5 (the review clause) of the Annex (WTO, 2005, p. 251)

4.4.3 Conclusion

Air transport is a vital and increasingly important component of the international trading system, both in terms of its direct contribution to international trade and as a facilitator of international trade in goods and services in other sectors. The regulatory process based on bilateral agreements, conceived in 1944, is under pressure as it tries to cope with the pace of change in the industry. The predominant regulatory response to this pressure has been to maintain the bilateral system, but to relax many of the provisions in these agreements. This process has been widely welcomed and the debate will continue as to whether or not the bilateral process is sufficient to meet the needs of the industry. A number of countries have concluded that the answer is no and have complemented their network of bilateral agreements with plurilateral agreements. Market access in the air transport sector is unique in its treatment within the WTO. To date, WTO Members have largely excluded the issue from the GATS Agreement, but are continuing to seek a better understanding of how multilateral cooperation and rules can best serve the industry. The question of liberalizing market access in international air transport is still the subject of a controversial debate. There seems to be a relative consensus that a bilateral process is not sufficient to meet the needs of such an internationally important industry. However, it is also not clear whether multilateral cooperation would provide an effective solution. In other words, the question remains as to whether the governance of international air transport services can be more efficiently handled at the multilateral level rather than through a network of more narrowly drawn-up agreements.

5 Concluding remarks

There are no doubts that standards have positive economic impacts on economic performance. In the complicated world of standards, different types of standards exert their own affects on economic issues at both micro and macro levels. Compatibility standards or interface standards enable network externalities, minimum quality standards or safety standards provide a solution to one of the most popular economic issues - the information asymmetry problem. In turn, variety-reducing standards open opportunities for firms to achieve mass production and mass distribution, and hence increase competition in the market. Finally, information or measurement standards provide a tool for technological diffusion, and reduce transaction costs. Given the objectives of this unit, three issues have been selected as representing the core of economics of standardization. The first is the interdependence between standards and technical change - which is widely agreed among economists as one of the most important economic fundamentals. It has been shown that standards can exert influences on technical change in a complicated manner. Whether and to what extent standards lead to technical change may differ from one case to another. Generally speaking, standards are pro-effective for technical changes. However, there are some cases, in which the existence of standards, especially those that are inflexible or even "false" can hamper innovation, and hence technical change.

The second emphasis is placed on the interrelation between standards and competition - which is believed to be the driving force of a market economy. It is important to bear in mind that both pro-competitive and anti-competitive effects of standards can be generated at the same time by one single standardization activity and its output (i.e. the publication of standards). These contradictory effects on competition may work simultaneously at the same market. In addition, these effects of standards on market structure also vary across the life cycle of the products or processes under consideration. Moreover, standards are likely to exert different types and degrees of impacts on competition at different development stages of the industry and the maturity of its technology. In other words, the impacts of standards on competitive market structure are influenced by the dynamics and speed of technical change. In such circumstance, there is no single answer to the question as to whether standardization facilitates or hampers market competition. As national economies have become increasingly integrated, the economic importance of standards has become one of the most controversial debates among economists in the recent decade.

On the one hand, it is logical to extend the pro-competitive effects of standards on competition towards international market structures. In this regard, standards exert a positive influence on the transactions of goods and services across borders. On the other hand, the existence of national technical standards, for instance, can be also considered as a variant of non-tariff barriers which

effectively hinder international market penetration, and hence international trade flows. As a result, standards have been included in the negotiations for regional integration arrangements as well as multilateral organizations such as WTO. The existence of the two WTO's Agreements on standards: the TBT Agreement and the SPS Agreement is the result of international coordination efforts to keep standards work for the benefit of free international trade. However, the problems of standards in international trade have been the subject of heated debate, especially because these standards have been used, in some cases, as technical barriers to trade. This suggests that standards will still be at the centre of negotiations between countries within and outside the WTO's initiatives.

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7 Glossary

Comparative advantages
The concept, formulated by British economist David Ricardo, according to which economic agents - people, firms, countries - are most efficient when they do the things that they are best at doing. Comparative advantage is particularly important in global markets, where countries benefit most by producing and exporting goods and services that they can produce more efficiently (at a lower cost, by using less physical, human, and natural capital) than other goods and services. In particular, Ricardo showed that a country can benefit from international trade even if it has higher costs of production for all traded goods and services relative to the countries it trades with - that is, even if it has no absolute advantages whatsoever. This can be done by correctly choosing the country's international specialization in accordance with its comparative advantages. In this case, by using export earnings to import other goods and service at prices that are lower than the costs of their domestic production, the country will maximize the overall volume of national production and consumption. (www.worldbank.org)

Direct network effects
Direct network effects arise when users benefit from being linked, physically or psychologically, to a large number of other agents. For example, in the case of

phone or e-mail networks, because consumers want to be able to communicate with a large group, they would perceive a larger network benefit as the number of network users increases.

Economies of scale
The increase in efficiency of production as the number of goods being produced increases. Typically, a company that achieves economies of scale lowers the average cost per unit through increased production since fixed costs are shared over an increased number of goods. Economies of scale gives large companies access to a larger market by allowing them to operate with greater geographical reach. But for the more traditional (small to medium) companies, size does have its limits, so after a point an increase in size (output) actually causes an increase in production costs. This is called "diseconomies of scale". (www.investopedia.com)

Indirect network externalities
Indirect network externalities are obtained when each user must join two or more components belonging to different networks to derive potential network benefits. With respect to indirect network externalities, if a consumer buys a certain product today, it does not alter the current utility of the others. However, today's buying decision has certain effects on the variety and prices of compatible components in the future. Consequently, the consumer's decision today affects his/her utility in the future. In this case, there is an incentive for consumers to choose the most popular product in an attempt to obtain more benefits from the supply of other supplements in the future.

Information asymmetry
In economics, information asymmetry occurs when one party to a transaction has more or better information than the other party. (It has also been called asymmetrical information and markets with asymmetrical information). Typically it is the seller that knows more about the product than the buyer; however, it is possible for the reverse to be true: for the buyer to know more than the seller (en.wikipedia.org). Information asymmetry was originally introduced by Akerlof (1970) when talking about the market for lemons. This economic concept has been modified in different areas. In the context of standards, the information asymmetry refers to a situation when buyers of certain products have less information than the sellers. If customers are not able to distinguish high-quality goods from other low-quality ones before buying, the supplier of the high-quality goods will find it difficult to sustain a price premium. In this case, he may not be able to survive if his cost exceeds that of the other competitors who sell low-quality products. The low-quality sellers will then drive high-quality suppliers out of the market by undercutting them. Consequently, the market for both the producers and the customers of high-quality products will break down, meaning a severe market failure.

Information standards or measurement standards
Standards help provide evaluated scientific and engineering information in the form of publications, electronic data bases, terminology, and test and measurement methods for describing, quantifying, and evaluating product attributes. (Tassey, 2000, p.4)

Learning cost
This cost is a component of the switching cost. This cost is incurred when customers need to be familiar with and to learn how to use the new system/products that they have decided to switch to.

Market power
Power held by a firm over price, and the power to subdue competitors (www.econport.org). In economics, market power (sometimes called monopoly power) is a market failure which occurs when one or more of the participants has the ability to influence the price or other outcomes in some general or specialized markets. The most commonly discussed form of market power is that of a monopoly, but other forms such as monopsony, and more moderate versions of these two extremes, exist. Market participants that have market power are sometimes referred to as "price makers", while those without are sometimes called "price takers". (en.wikipedia.org)

Mass distribution
This term is similar to mass production. However, instead of the focus on production, it implies a large volume of goods and services in distribution at low distribution costs. With mass distribution, firms benefit from economies of scale as the distribution cost per unit is low.

Mass production
A production system characterized by mechanization, high wages, low prices, and large-volume output. (www.economics.about.com)
This usually refers to factory processes on metalwork, not to textiles or agriculture. The term came into use in the 1920s and referred to production approaches analogous to those of the Ford Motor Company in the US. In economics, economies of scale makes mass production possible.

Minimum quality standards or safety standards
These standards are developed to specify acceptable product or service performance along one or more dimensions such as functional levels, performance variation, service lifetime, efficiency, safety, and environmental impact. (Tassey, 2000, p.4)

Multinational corporations
A firm that operates in more than one country. (www.forbes.com)

Network externality
This network effect causes a good or service to have a value to a potential customer dependent on the number of customers already owning that good or using that service. One consequence of a network externality is that the purchase of a good by one individual indirectly benefits others who own the good - for example by purchasing a telephone, a person makes other telephones more useful. In the context of standardization, network externality refers to the benefit of having common standards as it allows the current users to benefit from the size of the network. (en.wikipedia.org)

Search cost
This cost arises when the customer needs to spend certain costs on searching for information on the alternative products before purchasing decisions are made.

SPS Agreement
This is one of the two currently existing agreements of the WTO on standards. The SPS Agreement applies to sanitary and phytosanitary measures. The SPS measure is any measure applied to protect human, animal and plant life or health within the territory of member countries from risks arising from the entry, establishment or spread of pests, diseases; additives, contaminants, toxins or disease-causing organisms in foods, beverages or feedstuffs; diseases carried by animals, plants or products thereof, or from the entry, establishment or spread of pests. (WTO, 2005)

TBT Agreement
This is one of the two currently existing agreements of the WTO on standards. The TBT Agreement covers technical regulations, standards and conformity assessment. In this Agreement, "technical regulation" is a document which states product characteristics or their related processes and production methods, including the applicable administrative provisions, with which compliance is mandatory. "Standard" refers to a document approved by a recognized body, which provides, for common and repeated use, rules, guidelines or characteristics for products or related processes and production methods, with which compliance is not mandatory. And "conformity assessment" is any procedure used, directly or indirectly, to determine that relevant requirements in technical regulations or standards are fulfilled. (WTO, 2005)

Utility
An economic term referring to the total satisfaction received from consuming a good or service. A consumer's utility is hard to measure. However, we can determine it indirectly with consumer behaviour theories, which assume that consumers will strive to maximize their utility. Utility is a concept that was introduced by Daniel Bernoulli. He believed that for the usual person, utility increased with wealth but at a decreasing rate. (www.investopedia.com)

8 Key questions

- Why do we focus on the impacts of standards on technical change, competition, and international trade?
- What is meant by "compatibility and/or interface standards"?
- What is meant by "minimum quality and/or safety standards"?
- What is meant by "variety-reducing standards"?
- What is meant by "information or measurement standards"?
- Do standards facilitate technical change?
- Are standards pro-competitive?
- How about international trade? Are standards good for international trade?
- Are standards ultimately pro-growth?

Wilfried Hesser · Axel Czaya · Nicole Riemer

Abstract

This unit is concerned with communicating the principles of standards development. In fulfilling this aim, it makes a basic distinction between the static and dynamic attributes of standards development. Chapter 2 first examines the static elements, particularly different regulatory environments, mechanisms of standardization and the relevant actors. In Chapter 3 these actors are allocated preferences, and certain patterns of behaviour in certain standardization situations are discussed. Finally Chapter 4 deals with a number of basic standardization issues, which at first give the impression of being simple but do in fact prove to be complex and, perhaps because of this, are rarely covered in the literature.

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1 Preface

The aim of this unit is to show that there are different ways to develop standards. Ultimately, the specific situation, i.e. the general framework, and the interests of the actors involved determine the way in which standards are developed and also the final outcome. From this setting, recommendations on conduct can be developed for the actors in standardization processes. Furthermore, criteria are developed for how a 'good standard' can be assessed and what makes a 'good standard'.

However, this module will not be able to deal with all the details of the different standardization processes. The ETSI Statutes and Directives, for instance, in which the principles and regulations of their standardization work are specified, cover well over 100 pages (ETSI, 2004). Instead, this unit is more concerned with demonstrating general features of typical standardization pro-cesses, together with their commonalities and differences. Readers interested in the details of standards development in certain organizations should consult the corresponding statutes and rules of procedure for the organizations in question (see e.g. ISO/IEC (2004), CEN/CENELEC (2002) or ETSI (2004)). These documents are largely freely available on the Internet.

This unit is divided into three sections: Chapter 2 is devoted to the 'Statics' in the development of standards. This may at first sound like a contradiction in terms because development tends to be associated with dynamics, or, in other words, movement and change. However, the development of standards takes place within a certain framework that has to be sufficiently acknowledged before the corresponding processes can be examined. In this context, Section 2.1 introduces the regulatory environment of standardization, Section 2.2 the most important mechanisms of standardization, and Section 2.3 the key actors in standardization.

Chapter 3 then examines the dynamics of standards development. To this end, the actors of standardization are first 'brought to life'. They have certain preferences concerning the form of a standard (and of course on the general framework of standardization processes). The patterns of behaviour in standardization processes result from these actors' preferences. Section 3.3 explains the strategic patterns of behaviour in standardization processes in more detail. The result of standardization processes is generally uncertain. In particular, there is a chance that the standardization projects cannot be guided to a successful conclusion and will therefore fail. The causes for the failure of standardization processes are discussed in Section 3.4. Some recommendations on conduct for participants in standardization processes then follow in Section 3.5.

Chapter 4 deals with some questions of a general nature, which may seem a little naive but - perhaps precisely because of this - are rarely given any treatment in the literature. As shown in Section 4.1, it is obvious at technical and economical level why standardization is carried out. However, are there any reasons beyond these technical and economic aspects why engineers have

created standardization? These questions are examined in Section 4.2. Section 4.3 poses another relatively straightforward question for which there is nevertheless no simple answer. What distinguishes a 'good standard'? Chapter 5 makes some concluding remarks.

2 Statics of standards development

First of all, it is useful to clarify what is understood by 'standards development' in this unit. Standards development means the conscious and deliberate work of a group of actors within a given institutional framework for the purpose of creating a standard.

2.1 The regulatory environment of standards development

The development of standards takes place within a certain framework of constraints which can only be altered with difficulty, if at all. In other words, they are static - at least in the short run. This framework is primarily set by the social order, the political system, the legal system and the state of technical and economic development, hence in principle every exogenous factor that may in any way affect the development of the standard. The regulatory environment sets the immediate framework for standardization systems. These are defined by the state, or, as in the case of the EU, by supranational organizations with sovereign powers. Where the private actors have the corresponding room to manoeuvre, they can also create their own framework for developing standards. Standards bodies like DIN or CEN are associations and/or non-profit-organizations created on the basis of private initiative.

2.1.1 From total state control to laissez-faireism

The state influence on standardization may take a diverse range of forms. The extreme cases here are complete state control, on the one hand, and complete laissez-faireism, i.e. the complete absence of state influence on the standardization activities of private actors, on the other. There is great diversity among the states in-between. For instance, the state may control standardization in certain areas and leave it to the private actors in others. See, for example, Falke & Schepel (2000), who describe the features of national standards bodies in the European Economic Area (EEA) and their incorporation into the state superstructure. The more freedoms the private actors have, the better the opportunities are of independently structuring standardization

processes and institutions. Considerations of the design of a standardization system and in particular standardization processes immediately raise the question of the given framework or regulatory environment. Conversely, one should expect a standardization policy that is workable and free of contradiction from a state machine that acts responsibly.

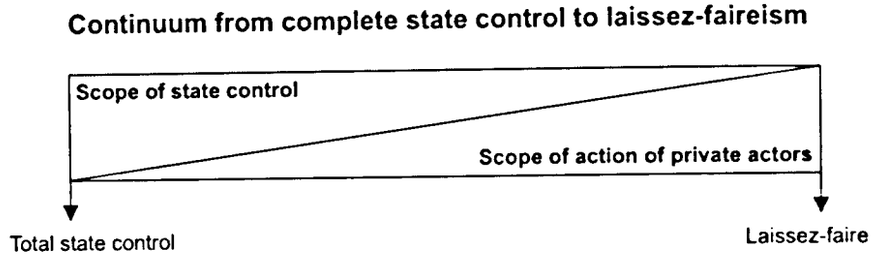


Figure: Continuum from complete state control to laissez-faireism (© W. Hesser, A. Czaya, N. Riemer)

2.1.2 Examples of regulatory environments

Using a number of examples, the following is intended to illustrate how different regulatory environments for standardization can be depicted on the continuum between full state control and complete laissez-faireism.

- In the Soviet Union, the standardization system was completely integrated into the state apparatus and entirely directed towards state objectives. Consequently, the standards issued by GOST had the status of laws. There was no room to manoeuvre for private actors (Czaya and Hesser, 2001, 33).
- The so-called 'Old Approach' of the European Community was a regulatory top-down approach that was introduced at the end of 1960 and was aimed at the harmonization of technical codes in the member states. To this end, the organs of the EC drafted technical specifications which were subject to mandatory adoption into the national law of the member states (Pelkmans, 1987).
- The New Approach of the EC superseded the Old Approach in mid-1980 after the latter had failed. Under the New Approach, the EC organs are merely restricted to specifying what are known as the 'essential requirements' in areas such as safety, consumer protection and environmental protection and leave the technical design of the corresponding standards to the European standardization organizations and private actors (Pelkmans, 1987).

- Standardization in Germany is a matter for the private actors and is largely centralized under the roof of the DIN. The relationship between DIN and the state is contractually regulated. In this respect DIN is granted a largely autonomous status and the right to represent German interests at the level of the International Organization for Standardization (ISO). In return, it commits itself to paying due regard to public interest. In countries such as Denmark and Great Britain, the relationship between state and standards body is similarly governed by contract (Falke and Schepel, 2000).
- The standardization system of the USA also grants the private actors a far-reaching degree of autonomy, but is additionally organized on much more decentralized and heterogeneous lines than the systems in other countries (ANSI 2005). Hence there are more than 600 organizations in the USA involved in the drafting of standards in a wide range of different fields and industries. Coordination activities and the representation of US interests at the level of international standardization is the responsibility of ANSI. However, crucial impetus for the standardization system of the USA emanates from the state and the military, which are themselves influential standards setters.
- A complete laissez-faire system, i.e. the complete absence of state or sovereign influence on standardization, cannot generally be observed in reality.

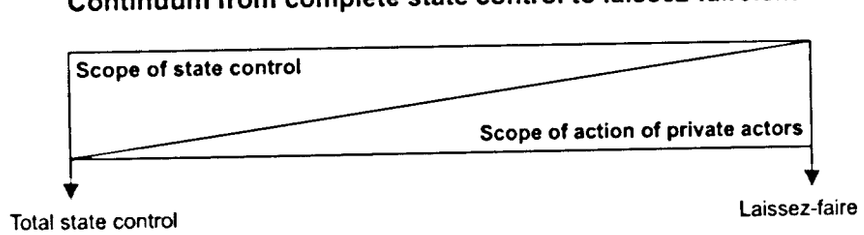


Figure: Continuum from complete state control to laissez-faireism - examples (© W. Hesser, A. Czaya, N. Riemer)

As emerges from Section 2.1, there is obviously some correspondence between the condition of a standardization system and its regulatory environment. In a totalitarian social system, for example, standardization is very likely to be completely integrated into the state apparatus and represent an instrument of surveillance or even compulsion. On the other hand, in a liberal social system, which weights the private autonomy of its members especially highly, state influence on the standardization activities of the private actors tends to be small. Consequently, conclusions can be drawn from the condition of a standardization system about the conditions of its social environment (Czaya & Hesser, 2001).

2.2 Standards development mechanisms

2.2.1 What is a standards development mechanism?

A standards development mechanism is a set of institutional rules that transforms certain inputs into certain outputs. A standardization process is the implementation, i.e. the specific execution of standards development mechanism. The output of a standardization mechanism or a standardization process is nothing other than a standard or a normative document. The input in turn is information that can be divided into the following classes:

- Knowledge: this means 'real information', for example scientific findings and technical know-how that is essential for preparing a standard.
- Preferences in the design of a standard: occasionally there are different preferences among the relevant actors as to how the contents of a standard should be designed. A standards development mechanism 'processes' these different preferences as well as the required knowledge and maps them onto a result, a standard or a normative document.

Bearer, transmitter and receiver of this information are the actors involved in a standards development process.

'Social mechanisms' (Schelling, 1998) are involved in standards development mechanisms that coordinate the behaviour and interaction of different actors. This also applies to market mechanisms, by means of which not only supply and demand are coordinated, but also standards ('de facto standards') can be established. In addition, standardization mechanisms are usually of a non-deterministic nature, i.e. the result that a mechanism produces may definitely be uncertain. This brief discourse on the term mechanism already indicates some of the features that distinguish standards development mechanisms:

- Although standardization mainly falls within the scope of applied sciences, standards development mechanisms can largely be assigned to the domain of social mechanisms.
- On the input side of a standards development mechanism, access criteria apply that specify which actors are allowed to take part in standards development processes under which conditions and in which form. One prerequisite for the successful progress of a standards development mechanism here is that the actors entitled to take part should convey the knowledge that is essential for the project. One further prerequisite stipulates that the interests of the actors involved should be sufficiently similar. See Section 3.1 on this topic.
- The standards development mechanism manifests itself as a steering structure which coordinates the interaction of the relevant actors. These actors input their knowledge into the standardization process and articulate their preferences on the design of the standard. How this happens and how this can be mapped onto a possible end result is stored within the standards development mechanism. Of particular importance in this context are the decision-making mechanisms employed in standards development processes, such as the principle of consensus or weighted voting mechanisms.
- The result of a standards development mechanism depends on various factors such as the decision making mechanisms employed, the nature of the articipating actors, their expertise, intentions and negotiating skills, and is generally subject to chance. Consequently, how a standard is ultimately designed remains uncertain at the beginning of a standards development process. In particular, standards development processes may definitely break down; 'no standard' is therefore also a possible result of a standards development process. See Section 3.4 on this topic.

The following presents the three archetypal standards development mechanisms and explains their characteristics. This concerns hierarchies, different forms of cooperation and the institution of the market (Kleinemeyer, 1997, 127), which, however, does not completely fit into the scheme, as explained in Section 2.2.4.

Classification of standards development mechanisms

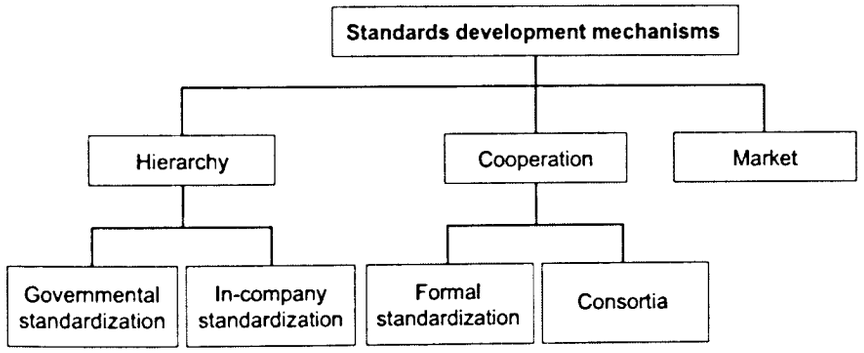


Figure: Classification of standards development mechanisms (© W. Hesser, A. Czaya, N. Riemer)

2.2.2 Hierarchies

Hierarchical standardization is principally characterized by a 'top-down approach'. This means that the development of a standard has to be triggered 'from above' in some form, or certain features of a standard, or even the entire

standard, have to be specified by a higher instance within the hierarchy. Consequently, hierarchical standardization presupposes the existence of hierarchical structures. At this point, particular interest is directed towards standards setting by the state, which has already been partially covered in Section 2.1, and company standardization.

State standardization

The state not only sets the general framework for standardization activities, but also occasionally exerts direct influence on standardization. In extreme cases, the state apparatus takes on all standardization activities. Specification of the standard by the state, or by suitable authorized instances of the state, is the oldest mechanism of standardization (Verman, 1973, 4). One feature of practically all early advanced civilizations was the existence of standards and the institutions of standardization, which were generally integrated into the state apparatus. Standards prepared by the state included those involving units of measure, units of weight and often construction regulations. In imperial China, for example, the wheelbase and axle length of carriages were standardized at a relatively early stage, and hence the corresponding breadth of roads and dimensions of city gates throughout the entire empire (Reihlen, 1991). The construction of the pyramids was largely governed by technical specifications. Without this set of rules, which not only specified details such as the lengths of the sides of the blocks of stone but also the working processes, it would have been practically impossible to build the pyramids.

The existence of standards or structures of standardization apparently corresponds to minimum requirements within a society, such as a sufficient knowledge of technology and natural sciences as well as a knowledge (or at least intuition) of socio-economic effects that can be achieved through standardization. It also demands sufficient institutional or structural conditions such as a highly developed bureaucracy in imperial China, by which means the relevant knowledge can be converted into the corresponding technical specification or standards.

As a matter of principle, standardization by the state exhibits the following features:

- Generally it is the state itself, or a hierarchical instance representing it, that identifies the benefit of a standardization measure and initiates a corresponding standards development process. Due to its extensive authorities, the state is in principle capable of bringing in all the actors within its sphere of influence that are required for executing a standardization measure.
- The state also particularly tends to seize the initiative when the public interest is affected and there is no incentive for private actors to implement the standardization measure. This is especially the case when a given standard has (at least partly) the character of a 'public good' and the actors involved in standards preparation are not in a position to take the benefits generated by such a measure for themselves. Under these circumstances, the state can standardize itself, exert pressure on private actors or subsidise private initiatives.
- When specifying standards, the state naturally acts with supreme control, by first giving priority to the state interests or steering objectives. If appropriate, the state also considers the preferences of other actors whose interests are affected by the standardization measures, sometimes appearing as a 'benevolent dictator'.
- Complete state control of the standardization activities corresponds with a completely hierarchical coordination of the courses of action of the relevant actors. This implies that the standards set by the state largely have the status of laws or regulations, the application of which is mandatory.
- State specification of standards is largely free of random influences.
- Often the objective that the state is pursuing through standardization consists in integrating an economic area or consolidating a sphere of power or influence.

In-company standardization

Decisions with great consequences are generally made in companies within the hierarchical structures. This is largely also true for in-company standardization (Hesser & Hoops, 2003). The impetus for an in-company standardization measure may come from a wide range of company divisions. In addition, the actors affected within the company will be consulted before such a measure is seized. Here a company may be able to resort to standards that it develops itself, 'import' standards from outside or use a mixture of the two. State-owned companies may possibly have binding rules as to which standards they have to observe. Whether and to what extent standardization takes place within a company depends on a range of different factors, such as the industry or sector, in-company structures, the internal company know-how, the 'awareness of standardization' within company management, the company's setting, in other words the regulatory environment for example, and the given standardization infrastructure outside of the company. This is a very broad field and can only be dealt with in part in this unit. In principle the modern company, which originated in the course of the industrial revolution, is also the starting point of modern standardization. During the introduction of new technologies and production processes, it was soon realized that the creation of uniform components, products and processes was capable of achieving a rationalization potential, in other words there was a possibility to save time and costs. The climax of this standardization in companies aimed towards rationalization came in the form of 'Taylorism', which experienced its heyday at the beginning of the 20th century (Taylor, 1947). However, this development also had its drawbacks, such as the monotony of uniform working routines and the alienation of workers from their labours or the product due to strict division of labour and standardization. Charlie Chaplin's film 'Modern Times' illustrates this in an entertaining way.

Traditional in-company standardization geared towards rationalization can still be found in a number of industries such as the automobile industry and is still an 'eternally youthful' classic discipline today. Mass customization therefore tries on the one hand to satisfy individual customer wishes while exploiting the rationalization benefits of standardization and variety reduction on the other. The platform concept for passenger vehicles is a good example of this (Hesser & Hoops, 2003, 104).
In management sciences, standardization geared towards variety reduction was largely neglected for a long time and was regarded as 'old hat' or less 'en vogue'. However, under the general term of complexity management, the classical methods of in-company standardization are experiencing something of a comeback (Samad & Weyrauch, 2000). And in actual fact, the importance of standardization for the modern company can seldom be overestimated. Without the corresponding standards, the general trend towards integration of pro-cesses and structures not only within the company but also beyond would be barely conceivable. It is not an exaggeration to maintain that virtually every new technology or method that is introduced in a company to improve the output of goods or services is based to a significant extent on appropriate standards. Or to express it another way, without suitable standardization the technologies and methods concerned do not develop their potential to the full. A current example of this is Radio Frequency Identification (RFID), which only achieves its full potential for rationalization in logistics and in supply chain management when uniform international standards exist (Roberti, M., 2004; Seidler, C., 2005).

2.2.3 Different forms of cooperation

In this chapter cooperative forms of standards development in formal standards bodies and consortia are investigated. Firstly, some attributes all cooperative forms of standards development have in common are considered. Secondly, some historical aspects of cooperative standards development are addressed. Thirdly, specific attributes of formal standards bodies and consortia are discussed.

1 Basic attributes of cooperative standards development
Different forms of cooperative standardization do of course exhibit differences, but also a number of (idealized) common features.

- One requirement for every (genuine) cooperation during the development of standards is that sufficient independent and equally ranked actors exist who have sufficiently similar interests and who are in a position to make a constructive contribution to the preparation of a standard. In the ideal case, standardization means that actors with equal rights and similar interests cooperate on the preparation of standards without any conflict.

- With more or less equal status, these actors now work or negotiate on the design of a standard. Consequently, the participants find themselves in a bargaining situation.
- The equal ranking amongst the participants implies a consensus in terms of the modalities of the negotiation process and decision-making, hence in the 'constitution' of the cooperation. In actual fact, consensus is also strived for during the design of a standard.
- Cooperative forms of standardization are often designed in multiple stages, with negotiations on the design of a standard generally representing the first stage. The results of these negotiations then provide input for the next stages. Here, for example, it involves the actual decision for a standard, which according to the 'constitution' often has to be reached unanimously or - as is the case in classical/acknowledged standardization - a public enquiry stage.
- If a consensus cannot be reached, it may be necessary to use other decision-making mechanisms such as weighted voting procedures. Under certain circumstances, a standardization project may also fail (see Section 3.4).

What has previously been stated on cooperative forms of standardization is, however, extremely idealized. In reality a number of deviations occur:

- Often the participants who take their places at the negotiating table are by no means of equal ranking. Power asymmetries exist, i.e. certain actors have a greater influence on the results of the negotiation than others. This may for example be due to their being equipped with differing resources. An actor who has considerably more or even exclusive knowledge, such as a bottleneck technology that is indispensable for the preparation of a standard, naturally has a better bargaining position over the other actors.
- The position of power that an actor has outside of the bargaining situation is also transferred to the negotiations. From the outset, a major international corporation will have a different starting position than a small enterprise, for example, that only operates regionally.
- Different actors have different bargaining skills. These skills may also be interpreted as a resource.
- There is room for strategic and opportunistic behaviour in different bargaining and decision-making situations.
- Participation in the standards development process is made difficult for certain stakeholders although they have an interest in participation and would be able to make a substantial contribution. For instance, the travelling expenses required to attend meetings may even exceed the budgets of small and medium-sized enterprises. In the case of consortia, certain actors may be excluded from participating at the very outset.
- Consensus should not be confused with unanimity.

Chapter 3 investigates the way in which these 'deviations' act within cooperative standards development processes in more detail.

2 Some historical aspects of cooperative standards development

The pre-industrial age was dominated by the state hierarchical specification of standards. However, there are also prominent exceptions such as the city state of Venice and the Hanse, the northern European guild of merchants. In both cases, power, influence and wealth were based on the respective fleets. Above all, standardization was concerned with the ships that made up the fleets. Venice, in particular, had astoundingly advanced methods of standardization: not only were certain construction features of the ships standardized but also production processes. The basis for this was highly developed methods of design and technical drawing.

The institutionalization of cooperative standardization, i.e. the founding of the first standards bodies began at the start of the 20th century. During the course of the industrial revolution in-company standardization first represented an instrument of rationalization, which made mass production possible and in some cases meant a competitive edge over rivals. In this respect many companies had no particular cause to make their own methods of standardization public, or even unify certain features of their approach throughout all the companies within an industry. Nevertheless, during the course of industrial practice, the usefulness, if not the necessity, of cross-company standardization began to emerge:

- It is known that industrialization did not proceed without friction. The introduction of new production technologies was accompanied by many serious accidents, e.g. exploding boilers. It very soon became apparent that there was a need for general technical specifications to guarantee an increased level of operating and working safety. However, this was difficult to impose by law; instead it required the technical expertise of the engineer and a suitable method of coordination to produce a technical specification of this kind. In Germany, for example, the problem of safety in steam boilers was a crucial factor in the foundation of the technical control boards ('Technische Überwachungsvereine').
- Engineers organized themselves into associations at an early stage, which rapidly took the first steps towards cross-company standardization. In the German Empire these organizations issued the forerunners of regular standards, known as 'Normalien', in which for instance the 'best practice' in the various areas such as safety was laid down. The Association of German Engineers (Verein Deutscher Ingenieure e.V. - VDI), founded in 1854, played a key role, for example, in the introduction of the metric system in the German Empire.
- Advancing technical and economic integration was characterized by an increased horizontal and vertical exchange of services, i.e. the formation

of new interfaces and increased transfer rates of services and information between companies of the same and different industrial sectors. The need for improved interoperability between the different social subsystems that grew from this implied a greater need for cross-company standards. This is particularly true of the field of electrical engineering, in which the benefit of or need for the most extensive degree of standardization possible manifested itself in an especially dramatic form. As a result, the IEC was founded as early as 1906 - significantly before the ISA, the predecessor of the ISO.
- A further decisive factor in the systematic institutionalization of cross-company standardization was military demands. Hence important impetus for the foundation of national standardization organizations in Europe came from the procurement policy of the War Office in England, for example, or also the systematic orientation of the German Empire's industrial complex towards its war objectives during the First World War (McWilliam, 1999).

3 Principles of 'classical' consensus-based standardization

Irrespective of their field of work and their geographical domains, standards bodies are guided by a series of basic principles in their activities. The work of the Deutsches Institut für Normung e.V. (DIN), for instance, observes the following basic principles:

- Voluntary basis: nobody is forced to take part in a standardization project. Similarly, the use of standards remains voluntary as a matter of principle.
- Open book: all standardization projects and draft standards are subject to public scrutiny - even from those quarters who have not directly been involved in the preparation of a standard.
- Open door, participation of all interested groups: Every actor who has an interest in a standardization project also has the right to take part in it.
- Uniformity and consistency: standardization work is aimed at a uniform and consistent system of standards.
- Application of the consensus principle in standards development procedures: the consensus principle is the dominant decision-making mechanism.
- Orientation towards the state of the art. The aim is to incorporate the current state of science and technology into standards. This expresses a demand on the information that it is to provide the input for the standardization process.
- Orientation towards economic conditions: This articulates the basic principle of efficiency, i.e. standardization should produce an economic benefit, e.g. in the form of rationalization in production or through the lowering of transaction costs. To the same extent, a certain standardization discipline is imposed; standardization should not degenerate into a means unto itself.
- Directed towards the common good: the common interest is placed above the particular interest.

- Global approach, or expressed in more general terms: a standards body for a certain geographical domain recognizes the primacy of the neighbouring higher level. The highest position in this respect is allocated to international standardization.

Principles of formal standardization

- Voluntary implementation
- Public access
- Broad participation
- Consensus
- Uniformity
- Consistency
- Relevancy
- Current knowledge
- Current technology
- Efficiency
- Of benefit to all
- International

Figure: Principles of formal standardization (© 2005 DIN Deutsches Institut für Normung e.V.)

This or similar content can be found in the articles of association and statutes of many other national, supranational and international standardization organizations (see e.g. ISO/IEC (2004), CEN/CENELEC (1999) or ETSI (2004)). Stan-dardization organizations that perform their work in accordance with the above principles are often formally acknowledged by the state. In actual fact these basic principles of standardization form a kind of reference state. Standardization in consortia is characterized by the fact that it is directed towards the principles of consensus-based standardization yet may deviate from these principles in one way or another. This will be illustrated in the next section. The above principles manifest themselves as follows in the standardization process, which for general purposes can be divided into four phases.

DIN standardization process

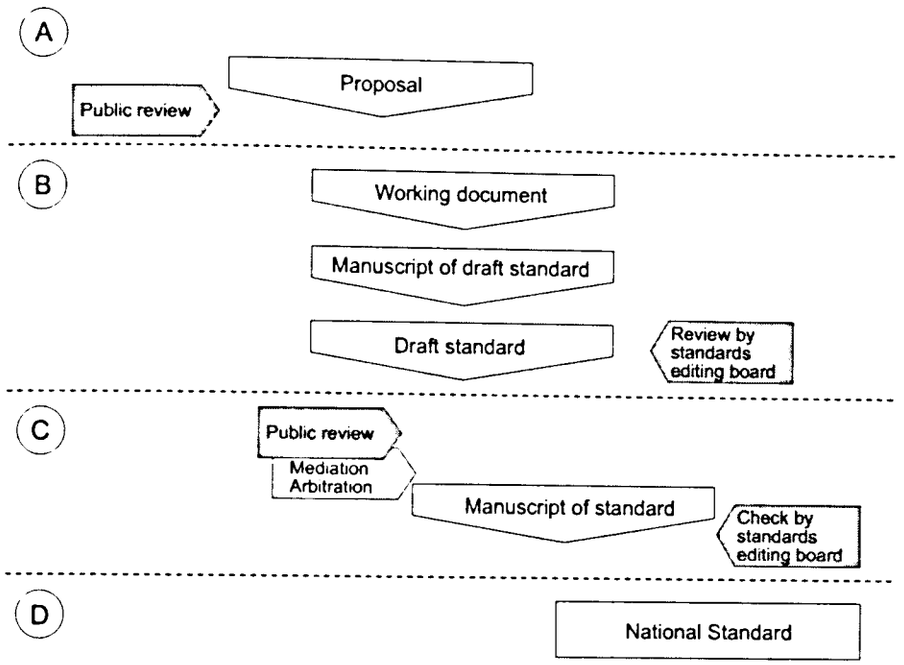


Figure: DIN standardization process (© 2005 DIN Deutsches Institut für Normung e.V.)

A) Proposal Stage

At the beginning of a standardization process is the substantiated proposal to standardize a new set of facts. At national level, standardization proposals may in principle be submitted by any person or legal entity. This proposal is examined in the responsible standardization committee in terms of the need, willingness for involvement by the interested parties, overlap with existing proposals, levels of preparation and provision of financing, and then a decision is made on whether to accept or reject the proposal. If a standardization proposal is accepted, the public is informed of the new standardization project.

B) Committee Stage

If the standardization proposal is accepted, either a new technical committee may be formed or an existing committee is charged with the work of drawing up the standard. If the standardization proposal is based on a working document, this will form an initial draft standard. Otherwise a small working group will be formed, which will first develop a working document of this

kind for further consultations. This working document provides the starting point for subsequent work in the technical committee. In the technical committees themselves, the specialized work is carried out by experts who have been delegated to the task of standardization by the interested parties (see Section 2.3), and are supported in this by full-time employees of the acknowledged standards bodies. The initial aim during this working phase is to draw up a draft standard and reach a consensus with the remaining members of the technical committee. Before the draft standard is passed and notified, a standards editing board examines the manuscript for compliance with the principles of proper stan-dardization work. If there are no reservations in this respect, the public will in turn be informed of the progress in the work.

C) Approval Stage
The draft standards can be examined by interested parties. Within a specified period of time, every interested legal entity or natural person can submit comments of approval, objections, proposals for amendments or additions indicating their reasons to the responsible standardization committee.
Every objection must receive treatment. Comments from the public are in turn discussed in the technical committee. The technical committee decides on the input of the proposals. This may result in an amendment but also complete withdrawal of the draft standard without any replacement. If the person submitting the comments does not agree with the decision of the technical committee, he may exercise his right to appeal in an arbitration process.
After all comments received have been dealt with, the technical committee can approve the text of the standard. The manuscript then undergoes another examination according to the principles of standardization. In the absence of any objections, there is nothing further to stand in the way of the standard being adopted.

D) Publication Stage
When the technical committee has reached agreement on the content of the standard and no further doubts exist as to the formal correctness, the national standard is adopted and released for printing. The standard is then accessible to the public and can be purchased. The reader should take into account that the process described is based on the formal procedures of the DIN, applies to the national level and has been represented in a stylized form. At national level the original concerns of the parties interested in standardization coincide in the standardization committees, whereas in supranational (European) and international standardization committees a national consensus that has been prenegotiated in national mirror committees is introduced. The procedures for supranational (European) and international standardization are largely similar to the national standardization process. The key differences refer to (Eickhoff & Hartlieb, 2002, 175):

- The groups that are allowed to submit a standardization proposal,
- Participation in standardization work,
- The weighting of votes in the approval of a standard, and
- The compulsion to adopt supranational standards.

Explanations on the European and international standardization process can be found in the following teaching units. If further information on individual standardization processes is required, the statutes and rules of procedure for the specific standards organization should be consulted.

National, European and International Standards Bodies

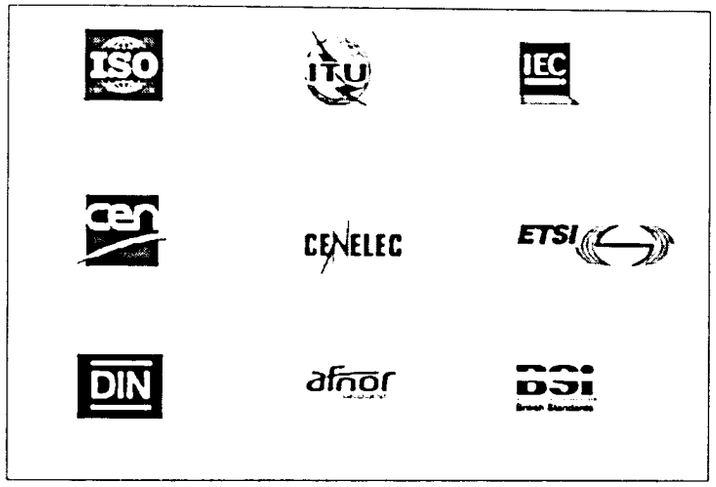


Figure: National, European and international Standards Bodies (© W. Hesser, A. Czaya, N. Riemer)

4 Consortia
Standardization in acknowledged Standards Bodies has been the dominant mechanism of standardization since the beginning of the 20th century. Towards the end of the 20th century market dynamics increased significantly and innovation cycles in products in some sectors such as ICT decreased rapidly (Cargill, 1999). In these cases, the classic standardization process was no longer in a position to make standards available in the time demanded. Consequently, companies meet the need for 'rapid standards' by founding their own standards-setting organizations. Known as consortia, they are frequently founded by companies from a certain industry on a more or less ad hoc basis, have a clearly defined working area and are often disbanded after a standard has been successfully prepared. In their work, consortia are guided by the basic principles

of consensus-oriented standardization but - if necessary - modify these in the interest of efficient, fast standardization. Compared to acknowledged Standards Bodies, consortia operate rather independently and need not necessarily take into account the interests of all stakeholders/interested parties or public interest as defined by the state or e.g. the EU. Consortia often exhibit a high degree of specialization which may impose an implicit, knowledge-based barrier to entry. The "price" that consortia sometimes pay for an accelerated and independent standardization process is that the output, the 'consortial standards', does not have the same legal status or legitimacy as standards.
The differences between some consortia and acknowledged Standards Bodies are rather small in some cases. For instance, the Organization for the Advancement of Structured Information Standards (OASIS [http://www.oasis-open.org]) exhibits institutional features very similar to those of acknow-ledged Standards Bodies. The relationship between 'classical' standards bodies and consortia is multi-faceted. In some cases, standards bodies view fora and consortia as competition and in others, there are cooperation agreements at different levels. For instance, standards bodies have for a considerable time been offering standards development processes and corresponding deliverables that resemble those in consortia and enable accelerated preparation of standards. One example of this class of 'New Deliverables' is the 'CEN Workshop Agreement' (CWA). CEN Workshops 'simulate' consortia-style standardization processes (e.g. workshop participants work and decide independently, strict consensus principle is abandoned), while providing professional support and infrastructure of an established Standards Body. At the same time, the results of the work from consortia occasionally form the input for standardization projects in acknowledged standardization organizations, where they undergo further processing or promotion to 'regular' standards. Furthermore, standards bodies do themselves become involved in the work of consortia. Whether the mechanism of the consortium or acknowledged standardization is used for the purpose of preparing a standard also depends on the given standardization structures and the 'standardization culture'. In the USA there is a marked tendency to initially found a consortium and hence give free rein to private autonomy, as it were. In Europe, in contrast, an acknowledged standards body is usually approached for the submission of a standardization proposal. Or to express it another way, in Europe there is a tendency to deploy existing mechanisms and central structures whereas a separate mechanism is created in the USA.
For further information on consortia see e.g. Hawkins (1999) or Egyedi (2001).

2.2.4 Markets

Towards the end of the 20th century a certain reversal took place in the causal relationship between standardization and the market that had hitherto prevailed. Until then standards had usually conditioned the features of markets and

the behaviour of the market participants. During the course of the ICT revolution, which was manifested by the triumphant progress of the personal computer during the 1980s and has continued without interruption up to the present day, there was a turnabout in the causal relationships. It was now the market that produced the standards. The (more or less) conscious and targeted activity in standardization processes, which characterizes consortia, acknowledged standardization and the state specification of standards, was now augmented or replaced by the 'invisible hand' of the market, hence the interaction of suppliers and consumers, in the presence of certain specific market features, such as network effects. This surprising appearance of the market as a standardization mechanism is based on certain market properties, which are responsible for certain products or their features assuming a dominant market position. These market attributes are commonly called network effects and the corresponding products de facto standards (see e.g. Katz, & Shapiro (1985) or Farrell & Saloner (1986)). Network effects may appear in various forms. An especially prominent case is when the benefits of a consumer from acquiring a good not only depend on its intrinsic value (stand-alone value) but also on the number (and/or weight) of the consumers who have already decided to acquire this good (or its technological features). This interdependency of benefits is based, for example, on the fact that by giving preference to a certain product, consumers are able to interact more easily. In other words, they can more readily communicate, coordinate their patterns of behaviour or also undertake transactions, and are therefore in the widest sense of the word 'networked'.
However, de facto standardization via market mechanisms is not of concern in this unit, because markets do not 'develop' standards in a strict sense. By coordinating the interplay between consumers and users on the one hand, and suppliers on the other hand, and given their specific attributes, markets instead tend to provide mechanisms for the selection of products (and services, of course). These products may incorporate (or carry) technologies or technical specifications which have the potential to become a standard, and eventually compete in the marketplace. The development of these technologies and technical specifications, however, does not take place in the market but rather one step earlier, i.e. in research & development or design departments of companies, in fora, consortia or acknowledged standards bodies. With regard to standards development we are apparently redirected to the first two categories of standardization mechanisms, i.e. hierarchies and cooperation. Further information on the market as a standardization mechanism can be found in Module 3 ('Economic aspects of standardization').

2.3 Relevant actors and interested parties of standardization

Until now, the general talk has been of the 'actors of standardization' or 'interested parties', without going into detail on who is actually concerned, what interests these actors are pursuing and what influence they exert on standardization. As a matter of principle, a distinction can be made between the following actors in standardization:

- Companies of all sizes from all conceivable industries.
- Consumers, users and employees, who are directly affected by standardization and who have a specific interest in various aspects of standardization. For all three groups, for example, the safety aspect is of major significance. In addition, consumers and users have a marked interest in ergonomic products, and, in this respect, also in the consideration of criteria such as usability and ergonomics in standardization.
- Associations and representatives of companies, consumers and employees, such as trade unions, chambers of industry and commerce. Certain companies, individual consumers, users or employees are generally not in a position or willing to represent their interests directly in standardization projects. This task is assumed by the associations mentioned above, which, for example, actively take part in standardization projects and exert the appropriate influence in the interests of their clientele.
- The scientific community, such as universities or research institutes. These actors primarily supply an academic input.
- Organizations that operate in the field of accreditation and certification. Standards make up the foundation for accreditation and certification. In this respect, the actors who operate in these areas have a distinct interest in accreditation-friendly or certification-friendly standards - or at least in being informed at the earliest possible stage on how the content of the standard is to be specified.
- National, supranational and international standards bodies, who provide the institutional framework for the above interest groups within which the standardization projects can be carried out.
- State and supranational organs with sovereign powers, such as the European Union (EU) for example, which exert influence on standardization in different ways within their sovereign territories (see Section 2.1).

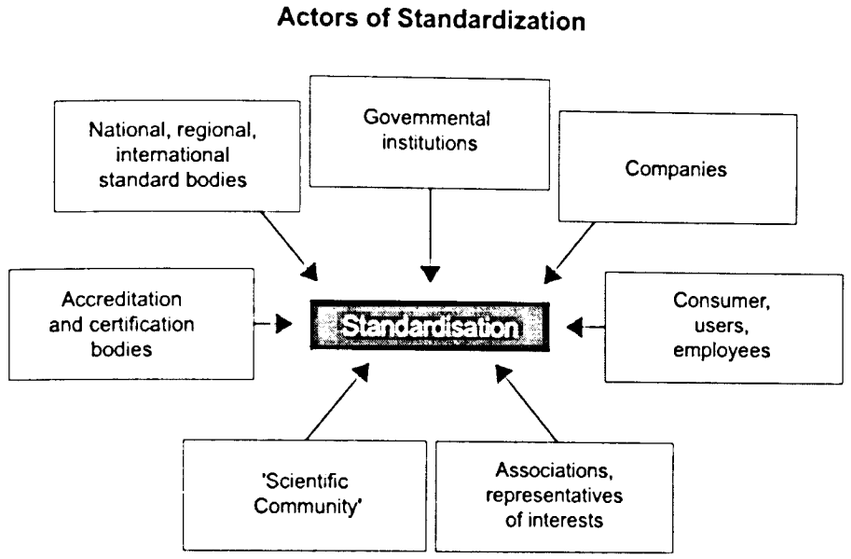


Figure: Actors of Standardization (© W. Hesser, A. Czaya, N. Riemer)

These actors in standardization are equipped with different resources that open up certain courses of action for them in standardization processes. Which interests these actors have and how they behave or interact in certain situations is examined in more detail in Chapter 4.

2.4 Summary of static elements of standards development

The static elements of standards development are summarized here once again:

- The development of standards takes place within a certain framework, which is usually set by the state or supranational organizations with sovereign powers. The state influence on standardization can extend from complete control to complete laissez-faire.
- Given this framework, the actors in standardization have different mechanisms of standardization and different methods of standards development at their disposal.
- Different actors in standardization - given the institutional framework and the resources with which they are equipped - have certain courses of action at their disposal (see Section 3.3). If there is sufficiently great room for

manoeuvre, certain actors even have the opportunity to shape the development of standards in line with their own ideas.

So much for the static elements of standards development. The dynamic element now becomes noticeable in the next chapter, with the actors in standardization becoming 'activated'.

3 Dynamics of standards development

The 'dynamization of standards development' takes place in the following way: initially, certain interests or preferences concerning the layout of the contents for standards are assigned to the actors (Section 3.1). If these preferences are viewed as given factors, they could also be interpreted as a static element and dealt with correspondingly in Chapter 2. However, the preferences form the "fuel" that causes the actors to perform certain actions. In addition, the preferences are by no means predefined but may change over the course of time and are subject to a certain dynamic element. Furthermore, under certain conditions the actors 'suffer' from biased preferences, or may even have an incentive to disguise their true preferences. Within the limits of their capabilities, the relevant actors will now become active in influencing the development of a standard in line with their interests. The effect this has and what results may come of this is explained in Section 3.2 by means of series of prototypical starting situations. Section 3.3 takes a closer look at the sociodynamics of the cooperative development of standards. Negotiation processes on the design of standards represent nothing more than social interaction. Even in (nominally) cooperative standardization processes, it is conceivable for the entire spectrum of behaviour to be manifested, from peaceable, purposeful cooperation to aggressive reactions and open conflicts. Ultimately standardization processes may even fail. The reasons for this are considered in Section 3.4.
Dynamic aspects of standardization have received a considerable boost in attention recently. See e.g. Fomin (2002a), Fomin (2002b), Egyedi & Heijnen (2005) or Bolin (2004) on various dynamics-related issues.

3.1 Actors' preferences over the form a standard should take

Different actors have different interests in standardization, with the following questions being raised for every relevant actor:

- Is it fundamentally beneficial for a standard to be created or not? For instance, suitable standards may unify the competitive conditions on a market and hence create a level playing field for all companies. Here it can be generally expected that a company which enjoys a competitive edge without standardization is likely to reject the development of standards that change this situation.
- If standardization is beneficial, how should the standard be designed? There may be circumstances in which there is literally an infinite variety of opportunities to design the content of a standard. In such a case there is obviously a need to reach an understanding or to negotiate. Potential conflicts in this situation often result from the participating companies wanting to create the standard that is to be developed so that it corresponds as closely as possible to their own internal specifications. This is generally aimed at minimizing the costs incurred within the company in adapting to the new standard.
- Further questions are raised concerning the framework in which standardization is to take place, which standardization mechanism should be selected, and how to behave within the given framework.

The following makes use of a simple benchmark, namely the alignment of interests or preferences among the actors. One especially important consideration is the degree to which the interests of the relevant actors are identical. If the interests of all actors are completely identical, there is fundamentally no potential for conflict and the standard development process should in this case take place in a spirit of cooperation and consensus. However, as soon as this uniform orientation of interests no longer exists, the potential for conflict will rise and the behaviour of the actors will become increasingly strategic or even opportunistic. In an extreme case, the interests of the actors may be diametrically opposed and conflicts will be fought out with all available means, even illegal ones if need be (Schmidt & Werle, 1998, 116).

3.2 Prototypical standardization situations

3.2.1 Win-win situations and coordination standards

Win-win situations in their ideal form are characterized by the fact that all relevant actors derive a positive benefit from the development of a standard. The interests of all relevant actors are therefore completely identical. There are, however, different nuances in this situation:

- There is an optimum alternative for how the standard should be designed, hence a first-best solution for example. It may be necessary for experts to convene in order to find this optimum solution.
- There are different but equivalent alternatives for designing a standard. Which standard is selected plays no role; the decisive factor is that all relevant actors agree on one standard. Consequently, there is a need here for

suitable coordination mechanisms by means of which relevant actors reach agreement on one specification, one 'coordination standard'. This could, for example, be standardization in acknowledged Standards Bodies or also in a consortium.

- Admittedly, all actors profit from the development of a standard, but to differing degrees depending on the design of its contents. The reason for this, for example, may lie in the differing adaptation costs incurred by the actors due to different versions of a standard. This may itself conceal potential conflict if, for instance, one actor is not prepared to bear higher adaptation costs than another.
- If the poles are reversed, then a 'no-win' situation exists, i.e. no relevant actor would derive a positive benefit from the development of a standard. The interests are therefore completely identical in this case as well.

Win-win situations obviously correspond with the cooperative forms of standardization as no potential for conflict exists and it is primarily technical work that has to be performed. As a result, Standards Bodies frequently refer to win-win situations to demonstrate the advantages of standardization: 'Play an active role in standardization as every interested party will benefit from doing so.'

3.2.2 Divergences from win-win-situations

Win-win situations represent the ideal and tend to be rarely encountered in practice. As a rule greater or lesser differences of interest can be expected if not conflicts of interest. Whether and how the development of a standard now proceeds, depends to a large degree on the type and extent of the differences in interest. The greater the differences in interest and the greater the number of opponents, the greater the potential for conflict will be and the probability of aggressive and strategic, opportunist behaviour; the greater too will be the divergence from the principles of consensus-oriented standardization. One important factor that has a decisive influence on the result of such a conflict situation is the how the actors are equipped with certain resources, such as a bottleneck technology or the bargaining power that results from such equipment. Furthermore, the element of chance plays a greater role if the interests of the actors diverge. It is uncertain whether a standard will be produced at all (see Section 3.4), how this standard will be specified or whether even several similar standards may coexist or compete.
Depending on the type and extent assumed by the contrasting interests among the relevant actors, the following (categories of) scenarios are conceivable:

- Amongst some few actors with little influence, the interests will deviate only moderately from the general interest. In these situations the art of persuasion, negotiation skill, group pressure or even 'package deals' and 'side payments' will still be sufficient to cancel the resistance of these actors.
- Exclusion of 'stubborn' actors from the development of standards. This can take place in two ways:
  - They are barred from access to the standardization process from the very beginning. This guarantees the homogeneity and equality of the interests of the actors involved in developing a standard.
  - If unanimity or consensus cannot be reached during the standardization process, then those putting up resistance can be excluded by changing the regime of the decision-making process, e.g. by transferring from the principle of consensus to a form of qualified majority voting (see e.g. CEN/CENELEC, 2002, 12).
- Forming coalitions and parallel processing in the development of the standard. Under certain circumstances, coalitions may form which, although they contain identical interests, are involved in conflict with each other. Frequently they are influential actors, such as companies which have a technological leadership or towards which everything gravitates. These coalitions now compete and try to enforce their own specifications as the standard. In this situation even the choice of standardization mechanism proves to be a strategic variable. For instance, one coalition may form a consortium whereas another coalition may initiate a standardization project within an acknowledged standards body. The first consortium aims at developing and disseminating a standard as quickly as possible while the second consortium strives towards a standard with greater legitimacy. Coalitions naturally compete on markets with their specifications as well.
- Open conflict represents the last stage in the process of escalation. At this stage coalitions will employ all legal and possibly non-legal methods in order to establish their own specifications as the standard (see Section 3.3). The mere existence of differing coalitions is already an indication of major contrasts in interest.

If necessary, the next higher instance, such as the state for example, may intervene if the contrasting interests of the private actors cannot be overcome or if there is no incentive to develop a standard. This is particularly true if the state sees that the public interest is affected. In cases of public interest, the state may organize the situation so that firstly a standard is created and, secondly, so that this standard complies with the state's own controlling objectives.

3.3 Strategic behaviour in cooperative standardization processes

Coalitions can of course also be formed in bargaining situations with a nominally cooperative alignment. The difference to the scenarios described in Section 3.2 is now that the bargaining situations involve direct social interaction. Here the

entire spectrum of human behaviour is conceivable. However, fundamentally a distinction can be made between cooperative and non-cooperative patterns of behaviour.

Strategic behaviour in cooperative standardization processes

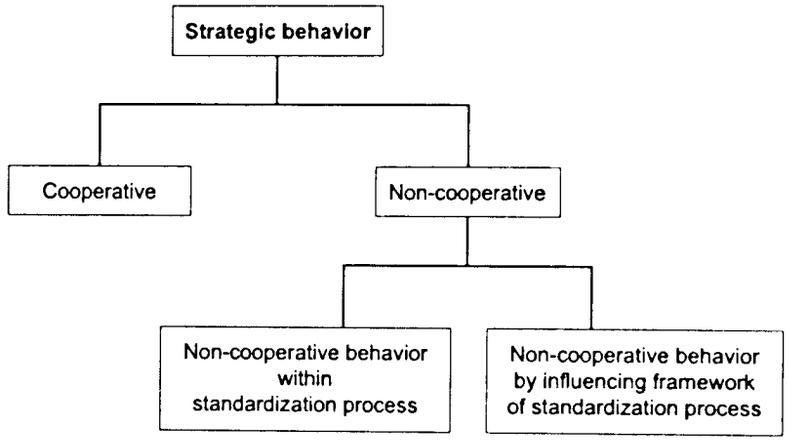


Figure: Strategic behaviour in cooperative standardization processes (© W. Hesser, A. Czaya, N. Riemer)

3.3.1 Cooperative behaviour

Cooperative behaviour can be expected above all in win-win situations. This corresponds with the use of appropriate standardization mechanism, such as consensus-based classical standardization or a consensus-oriented consortium. Within this general framework, cooperation ideally means:

- The actors do not behave opportunistically.
- The actors exercise their rights specified by the standardization mechanism and fulfil their obligations to the same extent. The obligations primarily consist in a constructive contribution to the standardization process, particularly the input of essential knowledge. Rights and obligations are generally distributed symmetrically among the participants in cooperative standardization processes.
- The extensive convergence of interests between the participating actors favours a conflict-free and objective standardization process.
- If no objective reasons stand in the way, the standardization process should actually produce a standard that meets the requirements of all relevant actors.

3.3.2 Non-cooperative behaviour

If there are sufficiently large differences of interest among the negotiation partners, there is an incentive for certain actors to stray from the line in the bargaining process. This behaviour is based on an individual strategic plan and contains the above-mentioned conflictual element. However, fundamentally a distinction can be made between two patterns of non-cooperative behaviour: non-cooperative behaviour within standardization processes and influencing the general framework governing standardization processes.

Non-cooperative behaviour within standardization processes
Non-cooperative behaviour may take on a number of different forms in standardization processes. All forms of 'backdoor' policy may definitely be found, including furtive formation of coalitions outside of the actual institutional structures, involving coordinated action, intimidation, threatening and blackmailing other participants, bribery and strategic handling of information in order to force conforming behaviour. The strategic handling of information is also widespread, with examples such as the withholding of or delayed disclosure of relevant information or even the dissemination of half-truths or false information.
Occasionally obstructive behaviour is found, manifested by certain actors not participating in a standardization process in order to make a constructive contribution but in order to delay or even cause it to break down entirely.
Sometimes participants in the bargaining processes behave in a contradictory manner in order to sow confusion and inhibit a standardization process. During multi-stage decision-making processes, for example, certain actors may be seen to approve a standard in the first stage and then vote against with a 'no' in the second stage (Schmidt & Werle, 1998, 181).

Influencing the general framework surrounding standardization processes
Sufficiently influential actors can also attempt to alter the institutional framework within which standardization processes take place in line with their own interests. Obviously in this case, the strategic behaviour does not take place within the standardization process itself, but instead on the meta level, meaning the political or constitutional level. The following strategies are possible:

- The appropriate bodies, such as the General Assembly, can form the stage for attempts to alter the statues, rules of procedure or the general policy guidelines of standard bodies.
- Lobbying at the political level can be used to work towards a change in the framework of certain standards bodies or the entire standardization system.
- Certain forms of standardization can be systematically favoured and others neglected or also new standardization structures established that compete with the existing structures.

3.4 Breakdown of standardization processes

Even though it is a subject that rarely tends to be discussed within the standardization community, there is still of course every chance that standardization processes will break down. The following explains a number of reasons for the breakdown of standardization processes.

3.4.1 Diverging preferences

As already indicated, the potential for conflict in standardization processes becomes all the greater as the interests of the relevant actors diverge. It only requires the contrasts in interest to be sufficiently large, particularly in consensus-based standardization processes, for the possibility of failure to arise. As mentioned previously, when there are distinctly contrasting interests, actors tend to behave in a progressively strategic and opportunistic manner and increasingly resort to conflictual strategies.

3.4.2 Bottleneck technologies and proprietary interests

The danger of a standardization process breaking down is especially great if, on the one hand, a certain actor has a bottleneck technology that is indispensable for a standard, and at the same time has a proprietary interest in this technology. An actor of this kind has a special bargaining power and can therefore bring a standardization process to a standstill with relative ease.

3.4.3 Insufficient input of know-how, insufficient expertise, insufficient bargaining skills

Standardization processes may also break down when the participants with the necessary expertise cannot be motivated to take part and/or the participating actors only have limited negotiating skills. In actual fact, the soft skills represent an important factor in standardization processes. Many standards bodies, for example, refer to the special position of the project manager in their rules of procedure. His skill and influence are often crucial factors in uniting opposing positions and resolving conflicts. However, soft skills and especially negotiating ability represent an asset for every participating actor. Companies in industries where standardization is especially intensive train their employees who take part in standardization processes in negotiation management and other soft skills.

3.4.4 Blurred image of standards development

Occasionally certain actors take part in standardization processes without having a clear idea of the essential features of cooperative standardization. One prominent example is the failed attempt to have Sun's Java recognized as an ISO standard. When the participants from Sun were supposed to disclose their own specifications during the standardization process based on openness and transparency, they withdrew from the project at short notice. Apparently, Sun viewed standardization with the ISO as an instrument to assert its own interests in the competition with Microsoft and thus have its own specification 'codified and ratified' (Egyedi 2001, 18), and equipped with a higher level of legitimacy. See Egyedi (2001, 15-26) for a detailed account and interpretation of the corresponding events.

3.4.5 Conclusions on a failed standards process

What conclusions should be drawn ultimately when the development of a standard breaks down? This depends on the causes:

- In the case of divergent, heterogeneous preferences, the development of a standard may not be expedient. In general, a standard that has broken down in a drastic manner would not have been expected to gain broad-based acceptance from the outset. Therefore in a situation such as this the breakdown of a standardization project should not be judged as thoroughly negative. Under some circumstances, the state may intervene in such a situation if it sees the public interest being affected.
- In the case of bottleneck technologies and proprietary interests, a distinction has to be made between two different constellations. If the particular interest of some few actors outweighs the general interest, the verdict will be negative. On the other hand, a company's or individual's right to exploit its own intellectual property rights (IPR) are an important driving force in entrepreneurial activity and have to be given corresponding consideration in standardization. Particularly in areas where many proprietary technologies form the input for the development of standards, a workable IRP policy is absolutely essential. Compare for example the ETSI Rules of Procedure in which the organization's own IPR policy occupies considerable space.
- It is of course a negative result if the development of a standard that would have met with broad acceptance fails due to a lack of expertise or negotiating skill. The same is true if it is not possible to secure the influx of necessary know-how. In a case such as this it is particularly important to reduce or eliminate any access barriers to the standardization process.

3.5 Micro-aspects of cooperative standards development

As in other bargaining processes, there is a micro-level of individual interaction in the development of standards which is either not or only partly covered by the formal institutional rules for standardization processes and is expressed in group dynamics. Examples of these micro-aspects, which may have a considerable effect on the result of standardization processes, include:

- The individual character traits of the actors taking part. Here, for instance, the charisma and negotiating skills of certain actors, or of course even character deficits, may determine success or failure. In extreme cases, an actor with charisma or a self-confident and dominant manner may steer the entire process, although formally he is not entitled to do so.
- Personal likes and dislikes may occasionally have a powerful influence on the technical work. In principle, people will tend to find a common stance with likeable negotiating partners rather than with unpleasant partners. Schmidt and Werle describe one example of how employees within a single company play out their animosities within the standardization process (Schmidt & Werle, 1998, 181).
- The sequence of events, actions and requests to speak. In some cases, even the order in which the participants at a negotiating session speak may influence the result. The tendency is for flamboyant, dominant personalities to have the first word and thus direct the negotiation along a certain course. The formal rules for negotiating and the influence on the person chairing the negotiations - if one is present at all - are specifically aimed at evening out such imbalances and bringing about or guaranteeing equality at the negotiating table.

3.6 Examples of cooperative standards development

At this stage it should be pointed out once more that it is not possible to include a detailed description of examples of standardization processes within the scope of this unit. The interesting examples are not only instructive and in some cases entertaining, but also relatively substantial, as not only the specific framework and technical details need thorough explanation but also the complex interaction that takes place between the actors involved. Consequently, the authors shall make do with a reference to some interesting sources of published material at this stage. Schmidt & Werle (1998) investigate the development of international telecommunication standard by means of three case studies. These examples illustrate how different political and economic interests and also the historical starting point and different national 'technology culture' can influence the development of standards. In their work, the authors examine the technical problems that occurred during the projects investigated.

Pelkmans (2001) shows how the GSM standard became a success, what obstacles had to be overcome during the process and the role played by political influence from the EU. Grindley (1995) provides a number of already classical examples, which illustrate basic mechanisms, incentives and patterns of behaviour in standardization processes very well. Spivak & Brenner (2001), Bolin (2002), Bolin (2004) and Bolin (2005) provide interesting and up-to-date examples in abundance. Of course, the reader may also refer to the various examples provided in this curriculum.

3.7 How to behave in standards processes

As a matter of principle, it is difficult to give generally applicable advice on how to behave in standardization processes. The specific situations and frameworks that apply in each case are too particular to allow this. However, a few general recommendations can be given on the attitude and the 'tools' needed to approach the development of a standard. This mainly involves answering some basic questions:

- What is the general situation and what is the general framework?
- Who are the relevant actors and how will their interests be affected by development of the standard in question?
- What opportunities do these actors have of asserting their own interests? What standardization mechanisms are available for the project, namely consortia, for example, or acknowledged standards bodies?
- What behaviour is to be expected from participants in the standardization processes?
- The fundamental questions are naturally directed towards an individual's own organization in particular: What is the individual's own situation like; what general framework is he bound by; what are his own interests and how will these be affected by the standard in question?

As soon as these questions have been clarified and a decision has been made to take part in a standardization project, a strategy or plan of behaviour should be drawn up. This should also include all eventualities, such as obstructive behaviour from other participants and so on.

4 What is standards development about?

4.1 Systemic, technical and economic aspects of standardization

As already shown in Unit 1, standards exert a number of technical and systemic functions. Examples include:

- Systemic and structural constitution, achieving compatibility or interoperability of technical systems. Structural constitution, for instance, can mean market constitution or even the opening up of innovation potentials.
- Storing time-invariant knowledge and first-best solutions. The wheel does not have to be continually reinvented.
- Storage and documentation of activities that can be turned into a routine.
- Variety reduction, lowering complexity.
- Defining quality levels.
- Defining safety levels.
- Reducing uncertainty.

These technical and systemic functions of standards have effects at the economic level:

- Reduction of interaction costs, such as transaction costs, communication costs or even coordination costs.
- Rationalization, i.e. more cost-effective or faster output of goods and services.
- Reduction of external effects.
- Steering of resources into productive or creative uses by relieving the burden of tiresome routine activities.
- Market constitution, market development, conditioning of market characteristics, increasing turnover.

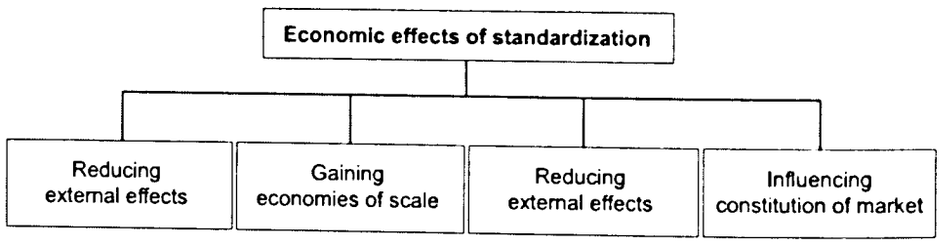


Figure: Economic effects of standardization (© W. Hesser, A. Czaya, N. Riemer)

These properties are the decisive reasons why standardization is pursued with the acknowledged degree of intensity throughout the world. In the next section, however, the reader will become familiar with another view of matters.

4.2 Standardization as an instrument of social influence

In principle, the systemic, technical and economic effects of standardization are sufficiently well-known. Authors such as Monthoux are additionally of the opinion that standardization represents an instrument with which engineers can exert social influence (Monthoux, 1981). Monthoux's decidedly unorthodox way of thinking is as follows:

- Standardization is normative. It does not describe what is but prescribes what should be (Monthoux, 1981, 107).
- Standardization satisfies a need for certainty, which is not least a result of the increased rise in uncertainty due to the advancing level of technology and scientific progress. However, it suggests a level of protection that cannot be achieved in reality (Monthoux, 1981, 16).
- Although occasionally the impression arises that standardization has a factual and scientific basis, it is in fact artificial. Consequently, an artificial world is created through standardization (Monthoux, 1981, 28).
- Engineers create - partly unconsciously due to their education and from tradition - this artificial world in order to establish a fitting position in society for themselves. In this function, they are in competition with other legislators, particularly lawyers (Monthoux, 1981, 77).
- A decisive criterion in the validity of a standard is not whether it is true or correct in the sense of scientific fact, but its formal authority or the willingness of users to follow the standard (Monthoux, 1981, 82).
- Engineers have a tendency to display uncritical obedience or dependence upon rules. This leads to an uncritical orientation towards standards which achieve a de facto binding force although their application is actually voluntary in the formal sense (Monthoux, 1981, 57, 130, 156).
- Amongst engineers there is a shortage of courage, willingness to take risks, to search for new solutions and to vary. In this respect help may come from innovative and bold entrepreneurs as personified by Schumpeter or Hayek (Monthoux, 1981, 198).

Even if one does not agree with Monthoux's theses, they do at least give cause to think about standardization other than from the technical and economic perspective. Readers are invited to form their own opinions on this. In any case, it is sometimes appropriate to think beyond the pure technical aspects of standardization and become aware of its social consequences.

4.3 What is a good standard, what is efficient standards development?

Surprisingly, the question as to what makes a good standard is relatively rarely given explicit treatment in the literature on standardization. This may be due to the fact that an answer to this question may vary according to the 'standardization ethics' of certain actors or where their interests lie. Bill Gates is no doubt convinced that Microsoft Windows XP or Windows Vista represents an outstanding standard in the field of operating systems for personal computers. A Linux aficionado or a representative of the open-source community would generally be expected to have a different opinion. Similarly, a representative of any standards body would naturally consider the standards from his own organization to be good standards. For a company, standards are good if they are tailored exactly to their needs and objectives. This is where the fundamental conflicts of interest in the development of standards are to be found. Sometimes there are even differing opinions on what the nature of a standard is supposed to be. If there are already differences in opinion at this level, then there is even less hope of a uniform option on what makes a good standard. For example, there is a different view in Europe and the USA on the features of an international standard. Representatives of the European standardization system are of the opinion that an international standard is characterized by the fact that it has been prepared under the auspices of an international standards body in accordance with the principles of consensus-based standardization. In contrast, for some representative of the US standardization system, an international standard is one that has asserted itself from the market side and is applied at international level. This view tends to be more competition-oriented and abstracted from the underlying standardization processes or institutional framework.
Despite these reservations, the following properties should nevertheless apply to a good standard:

- The standard meets the needs of the users or the interested parties.
- The standard is available to the users in time.
- The standard is formulated in a way that is comprehensible and free of contradiction in terms of its scope (inner consistency).
- The standard can be implemented by the users.
- The standard does not contradict other existing standards (outer consistency). However, this point is open to discussion because occasionally competition supports differing standards. In this way, the better standard is intended to assert itself, and innovation is not obstructed.
- The standard should tend to be more performance-based than prescriptive.
- The standard is sufficiently distributed amongst the users and is applied to an adequate extent by all interested parties. A standard that is not applied has no right to exist.

- If the development of a standard starts at an early stage, the lower the probability will be that economic interests might have already formed among the participants.

What then does the efficient development of standards mean? Attempts to answer this question give rise to problems similar to those seen in the case of 'good standards'. In the literature on standards development there are different opinions on the term efficiency, and consequently no uniform, generally applicable answer to what efficient standardization represents. Instead, there are specific answers based on certain industry-specific, professional or scientific viewpoints and related to standardization processes in certain industries, fields of technology or certain elements of the standardization process (e.g. access restrictions, voting procedures, etc.). In a similar way to the definition of a good standard, particular interests also play a role in the definition of efficient standardization. For a representative of the business community, the development of standards will presumably proceed efficiently if the result exactly matches his business interests. The demand for accelerated preparation of standards, for instance, largely emanates from the business community so that it can better survive in a noticeably fiercer, albeit partly self-induced, competition. For a representative of consumer interests, the development of standards will be inefficient if it pays no regard to consumer interests. To a representative of classical acknowledge standardization, efficiency could mean adhering to the principles of consensus-based standardization from Section 2.2.3.
At this juncture, the authors take the view that the development of standards is to a large extent efficient if the resulting standards meet the above criteria. The fundamental question is now whether these criteria can also be met in all situations. As a matter of principle, it will not always be possible to assume that the development of a standard will proceed efficiently and the result will be a good standard. However, in some areas it is conceivable that progress could be achieved without it detracting from efficiency in other areas. The use of modern means of communication and electronic decision-making tools ("e-voting"), for instance, will enable physical distances to be overcome, without there being a need to deviate from the principle of consensus.

5 Concluding remarks

An initial prerequisite for the draft of a workable standards development strategy is that within a company, particularly among the crucial decision-makers, there should be an awareness of the fact that standardization can in fact also be used as a strategic instrument by companies or competitors and that other companies do actually do this. This prerequisite is by no means as trivial as it may sound. During conversation, a prominent representative of DIN pointed out

how difficult it often is to explain to decision-makers who have no technical training the relevance of standardization for their company and what problems the proponents of standardization measures have within the company to find an audience at the decision-making level. Particularly in view of possible 'destructive patterns of behaviour' in standardization processes, the ethical dimension should be given some consideration. Acknowledged standards bodies frequently orient their principles towards the common good. For actors who participate in the development of standards under the auspices of an acknowledged standards body this implies an ethical demand to consider the collective interests, hence to move away from individual maximum demands in favour of a generally acceptable result. Those participating specifically in consensus-oriented standardization projects should be aware of this ethical dimension and reexamine their own system of objectives. As a matter of principle, an essential feature of standardization is that not only one actor but several and in the best case all relevant actors, all interested parties gain a benefit from it. Those who opt for cooperative strategies should not innocently assume that all other actors will also show unreserved cooperation. In actual practice, while one should not treat one's cooperation partners with permanent suspicion, it is still necessary to look for appropriate signals and developments indicating that certain actors are straying from the principles of cooperative standardization.

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7 Glossary

Accreditation
Procedure by which an authoritative body gives formal recognition that a body or person is competent to carry out specific tasks. EN 45020:1998, 12.11 CEN/BOSS Glossary: (www.cenorm.be).

Certification
According to EN 45020 "certification of conformity" is used to mean inspection by an impartial third party to show that a correctly designated product, process or service complies with a specific standard. In the context of legal harmonization, the issuing of a certificate serves as proof that the product meets specific laws or other technical specifications and criteria, i.e. it complies with or conforms to these.

Consensus
General agreement, characterized by the absence of sustained opposition to substantial issues by any important part of the concerned interests, and by a process that involves seeking to take into account the views of all parties concerned and to reconcile any conflicting arguments. (ISO/IEC Guide 2:1991, EN 45020:1998, 1.7, CEN/BOSS Glossary: www.cenorm.be). Consensus need not imply unanimity.

Consortium
Organization that is not formally recognized as a "promulgator" of public standards, but formed for the purpose of developing common technical specifications

for the use of its members, usually in narrowly defined areas.
(CEN/BOSS Glossary: www.cenorm.be)

De facto standard
A standard which because of its widespread distribution on the market is implicitly binding for all companies. It is referred to as 'de facto validity'.

DIN
The 'Deutsches Institut für Normung e.V.' (DIN) was founded in 1917 under the name of the 'Standards Committee for General Mechanical Engineering' and is the national standards organization in Germany. The DIN is a registered technology and science association with its own legal personality and operates on a non-profit-making basis. The job of the DIN and its subsidiaries is to elaborate technical rules, with assistance from all the interested groups (businesses, organized interest groups, the state), on the basis of consensus and transparency and to support their application.

Essential requirements
Requirements that represent the core of European Union law around which an effective policy has been developed in matters of safety, health and other measures for those areas covered by the "New Approach Directives". (CEN/BOSS Glossary: www.cenorm.be)

European Community (EC)
The European Community was established by the Treaty establishing the European Economic Community on 25 March 1957 in Rome. It was aimed at the 'harmonious development of economic activities', a 'continuous and balanced expansion' and 'increased stability'. To this end, a common (or single) market is to be created. The EC constitutes the most important pillar of the EU.

European Standardization System (ESS)
The European Standardization System (ESS) is constituted by the European Standards Bodies (CEN, CENELEC and ETSI) their structural interrelations, their structural relationships towards the European Union and towards other relevant actors.

European Union
The European Union is a family of European countries with similar basic values, political systems and common goals. It provides a framework for economic and political co-operation. Its 25 member states have transferred substantial elements of national sovereignty to the EU. The main goals of the EU are prosperity, freedom and the creation of a European identity.

General framework of standardization
All exogenous factors that in any way affect the development of standards. These are above all the social order, the culture, the political system, the legal system and the state of technical and economic development.

ICT revolution
General radical changes at the technical, economic and social levels caused by advances in the fields of communications, information and computer technology.

Industrial Revolution
term usually applied to the social and economic changes that mark the transition from a stable agricultural and commercial society to a modern industrial society relying on complex machinery rather than tools. It is used historically to refer primarily to the period in British history from the middle of the 18th cent. to the middle of the 19th cent. (The Columbia Encyclopedia, Sixth Edition (www.bartleby.com))

Innovation
Innovation... is generally understood as the introduction of a new thing or method... Innovation is the embodiment, combination, or synthesis of knowledge in original, relevant, valued new products, processes, or services. (Luecke, R. and Katz R., 2003. Managing Creativity and Innovation. Boston, MA: Harvard Buisness School Press, 2.)

Integration
Creation of a super system by coupling two or more systems. For instance economic integration of two countries implies abolition of all barriers to trade and measures such as a customs union and monetary union.

International standards bodies
These are the international equivalents of CEN, CENELEC and ETSI: The International Organization for Standardization (ISO), the International Electrotechnical Commission (IEC) and International Telecommunication Union (ITU).

Market
A market is a specific institutional arrangement consisting of rules and conventions that make possible a large number of voluntary transfers of property rights on a regular basis, these reversible transfers being implemented and enforced through a specific mechanism of regulation, the competitive price system (Ménard, 1995, p. 170). Ménard, C. (1995): Markets as institutions or institutions as markets? Disentangling some fundamental concepts. Journal of Economic Behavior and Organization, 23, 161-182.

Market attributes
The properties of a market that determine the relationship between supply and demand, and hence the characteristics that a product will need to succeed in this market.

Market dynamics
The change of market attributes and market variables (e.g. prices, demand, supply, growth, number of sellers and buyers, turnover, investment, market shares, etc.) over time. For instance the presence of network effects can dramatically accelerate the changing of market attributes and market variables.

Mirror committee
During supranational and international standardization, participation in the standardization process consists of direct participation in the mirror committees of the national standards bodies. In voting on supranational or international standards, these national delegations can only appear in a united form.
The mirror committee is responsible for working on the written documents, appointing the national delegation, supplying a version in the national language and casting the national vote on drafts. This committees also have to make sure that the broad-based specialized public within its country is summoned to give an opinion in time. (Falke 2000, 201)

National standard
Standard that is adopted by a national standards body and made available to the public. (EN 45020: 1993)

Network effects
"The benefit that a consumer derives from the use of a good often is an increasing function of the number of other consumer purchasing compatible items... we call these positive consumption benefits *network externalities*" (Katz/Shapiro 1986, p. 146). Katz, M.L./Shapiro, C. (1986): Product Compatibility Choice in a Market with Technological Progress. In: Oxford Economic Papers, Vol. 38, Suppl., 146-165.

New Approach
New Approach (07 May 1985): EC directives only specify the essential health and safety requirements; European standards define the requirements at a high level of protection; affected groups are to be involved in drawing up standards; provision is to be made for safeguard clause procedures.

Normative document
Document that provides rules, guidelines or characteristics for activities or their results.
NOTES: 1. The term 'normative document' is a generic term that covers such documents as standards, technical specifications, codes of practice and regulations.
2. A 'document' is to be understood as any medium with information recorded on or in it.
3. The terms for different kinds of normative documents are defined by considering the document and its content as a single entity. (EN 45020:1998, 3.1, CEN/BOSS Glossary: www.cenorm.be)

Performance-based standard
Standard, in which (minimum) target values or performance goals are specified, while detailed design prescriptions are avoided. Performance-based standards tell the user what target values and goals should be achieved with his product but not how they should be achieved. Thus, different technological solutions to meet a performance target remain viable and innovation is not hampered.

Regulatory environment of standards development
The characteristics a given market exhibits, e.g. number of buyers and sellers, distribution of market power, (production) technology, characteristics of the traded good or service, possible transaction costs, increasing returns to scale/network effects, barriers to entrance, the regulatory environment.

Standard
According to DIN EN 45020: 1993, a 'standard' is a document established by consensus and approved by a recognized body, that provides, for common and repeated use, rules, guidelines or characteristics for activities or their results, aimed at the achievement of the optimum degree of order in a given context.

Standardization
Activity of establishing, with regard to actual or potential problems, provisions for common and repeated use, aimed at the achievement of an optimum degree of order in a given context. (DIN EN 45020 : 1998)

Standardization committee
A standardization committee is responsible for an area of specialization or knowledge. (DIN 820, Part 3 No. 3.2.1)

Standardization mechanism
Set of institutional rules that transforms certain inputs - knowledge and preferences via the design of a standard - into certain outputs - standards and other normative documents. The holders of the relevant inputs are the actors who take part in a standardization process.

Standardization process
A standardization process is the implementation, i.e. the specific execution, of a standards development mechanism.

Standardization system
A standardization system of a given domain (e.g. the national, supranational or international level) is constituted by those bodies active in standardization, their structural interrelations, and its structural relationships with the environment.

Standards body
Standardizing body recognized at national, supranational or international level that has as a principal function, by virtue of its statutes, the preparation, approval or adoption of standards that are made available to the public. (EN 45020 1998, 18)

Standards editing board
The standards editing board carries out duties in accordance with DIN 820 and the resolutions of the Presidential Committee. It examines draft standards to ensure that the rules and principles of standardization work have been adhered to and, if the relevant conditions have been fulfilled, it adopts the standards in the German system of standards on behalf of the Presidential Committee. (DIN 820, Part 3 No. 3.2.15)

Technical Committee
The technical committee is the working group responsible for carrying out standardization work within the section of the discipline that it has been allocated. (DIN 820, Part 3 No. 3.2.5) A working group is a group in which the technical standardization work takes place. Working groups are therefore a generic term for the technical committee. (DIN 820, Part 3 No. 3.2.4)

Technical harmonization
This term refers to the approximation of national technical laws and regulations and especially of standardization repositories in order to create a genuine internal market.

Unanimity principle
The agreement of all persons involved in a decision over a set of given alternatives. Unanimity is not identical with consensus.

Weighted voting
Voting system applied for the approval of European Standards which consists in according specific weightings to votes cast by CEN members.

8 Key questions

- What range of state influence can be exerted on standardization?
- How presumably will standardization be organized in a centralist state?
- What legal status will standards presumably have?
- What are the main features of the standardization system in the USA?
- What are the 3 archetypal standardization mechanisms frequently mentioned in publications?
- What are the two most important forms of hierarchical standards setting?
- Where is the birthplace of modern standardization and what was the primary purpose of standardization?
- Name the relevant actors in standardization?What is meant by a win-win situation in standardization?
- Give examples of non-cooperative behaviour.
- Name the economic effects of standards.
- What should actors, e.g. companies, who wish to take part in the standardization process, consider?
- What does consensus mean in classical consensus-based standardization?

Chandana Perera

Abstract

This module deals with how standardization is employed in product design. One major focus of the module is on how standardization is used as a strategy to enhance competitiveness. In addition to standardization strategies, the importance and use of standardization and standards in product documentation are discussed in Section 4. Section 5 discusses the problems associated with product variety and highlights the importance of a balance between variety and standardization. Main strategies in standardization, including size range, component commonality, modularity, platform concept and postponement, are described from Section 6 to Section 10. For each strategy, the concept behind the strategy, relative advantages and disadvantages and design approaches are discussed with real-world examples. Concluding remarks are provided in Section 12.

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1 Preface

Product design is the initial stage of the product life-cycle. Success of the product in the other stages of the life-cycle mainly depends on the decisions taken in product design. In product design, standardization is used for different purposes. Product design should satisfy the various types of standards to meet the needs of the market, regulations, etc. The designer should be aware of standards in the target market. In addition to the market standards and regulations, standards required for other phases of the product life-cycle should be given due consideration in the design process. In the design process, another important area is preparation of the product documentation. Product documentation is used to communicate the relevant product information to the other phases of the product life-cycle. Product documentation should be prepared according to widely accepted standards so that the people involved in the other phases can correctly interpret the information. Standard documentation procedures of the product design are very important in this regard. Standardization can be used as a strategy to enhance the efficiency of production and other operations. The operational efficiencies are achieved by reducing complexity through standardizing the product and components. The designer has to understand the opportunities in standardization in the early design stage. Therefore the designer should be aware of different approaches to standardization and related costs and benefits at each stage of the cycle. The main aim of this lecture is to provide a knowledge of different standardization strategies and related costs and benefits. Such knowledge is useful to designers when deciding whether to implement standardization and selecting the most suitable standardization strategy. In compiling this lecture material, the author has used the published literature on different standardization practices.

2 Product development & design

2.1 Stages in development process (Pahl & Beitz, 1996, p.64 70)

Because of the complex nature of technology and the requirements of the market, it is not possible for an individual to handle the development and design of a product. Often a team whose members have different fields of expertise is required to handle the overall process.

The design process can be divided into four main phases:

i. Product planning and clarifying the task
ii. Conceptual design
iii. Embodiment design
iv. Detail design

It is not always possible to draw a clear borderline between these main phases. Neither is it possible to avoid backtracking.

2.1.1 Product planning and clarifying the task

Prior to the design of a commercial product, there has to be a product idea. A promising product idea will ideally lead to a technically and economically viable product. The product planning department should follow the development of a product idea through the design and manufacturing departments and then evaluate its market behaviour, which includes the financial position and market success of the product. The basis and starting point of product planning is marketing. The voice of the customer influences product planning. The success of the product is mainly decided by the level of customer focus - listen to the customer, understand the customer and respond to the customer. The stimuli for product plans come from many sources: the market, new technologies, new functions of a company, economic and political changes, new environmental regulations, etc. Irrespective of whether the product development is based on product planning or a specific customer order, it is necessary to clarify the task in more detail before starting on product development. This leads to the formulation of a requirements list for the product.

2.1.2 Conceptual design

After completion of the task clarification phase, the conceptual design phase determines the principle behind a solution. Developing conceptual design consists of several steps: abstracting the essential problems, establishing function structures, searching for suitable working principles and combining those principles into a working structure. Conceptual design results in specification of the principle. The designer can develop several concept variants and the most suitable concepts should be selected on the basis of both technical criteria and economic criteria. However the working structure cannot be assessed until it is transformed into a more concrete representation. This includes selecting preliminary materials, producing a rough dimensional layout, and considering the technological possibilities. The conceptual design phase consists of several steps. None of these steps may be skipped if the best solution is to be reached. The subsequent embodiment and detail design phases will be extremely difficult and not effective if there are any shortcomings in conceptual design.

2.1.3 Embodiment design

In the embodiment design phase, the designer determines the product architecture of the product starting from the concept. Embodiment design results in the specification of product layout. Producing several layouts to scale may yield more information on the advantages and disadvantages of the different variants. After sufficient elaboration of the product layouts, the embodiment design phase ends with an evaluation in terms of technical and economic criteria. The embodiment design can be further improved by incorporating knowledge from other sources and the most promising design should be selected for further development. Embodiment design provides a check of function, strength, spatial compatibility, etc. At this stage the financial viability of the product under development should be assessed.

2.1.4 Detail design

In this phase all the specifications required for production are determined. These include dimensions, tolerances, surface properties, materials, etc. All the product drawings and assembly drawings are developed. Embodiment design is optimized and final details are decided in this stage.

2.2 Relationship between design and other phases of product life

The decisions taken in the product design phase affect all the phases of the product's life-cycle. The phases of the product life-cycle are: design, manufacturing, distribution, usage and disposal. Design starts from the information of user requirements which are identified by marketing. The main objective of the design is to satisfy the user needs through the products to be designed. However, in addition to user requirements the designer has to look at the requirements of all the other phases in designing the product. Product design should satisfy the requirements of manufacturing and assembly. Products and parts should be designed avoiding the features that are difficult to manufacture so that manufacturing is economical. Parts should be capable of being easily assembled to configure the final product. In designing the product, the requirements of distribution - inventory control, transportation, storage - should be considered. Strategies such as modularity and delayed differentiation can be employed to reduce the inventory levels. The product should be designed so that it can be easily handled and should consume little space so as to facilitate easy handling and storage. In the usage phase, the design should incorporate the requirements for maintenance and services in addition to user requirements. As the importance of conserving natural resources and protecting

the environment increases, the recycling or disposal of products is becoming a major life-cycle issue. Many companies are now interested in product design that allows easy recovery and reprocessing of metal and plastic products. The above aspects should be considered in the embodiment design phase.

3 Use of standards in product design

3.1 Objectives of standardization

Standardization provides the definitive solution of a repetitive technical or organizational problem with the best technical means available at the time. It ensures quality in business, technology, science and administration. It serves the safety of the people. Standardization determines solutions in the form of national and international standards, of company standards or of generally applicable design catalogues. In the design process, standardization limits the range of possible solutions and is largely confined to the individual elements, sub-solutions, materials, computations, testing procedures, documentation, etc. Standardization also deals with limiting variety and providing definitive products. Standards are time-dependent and continually updated to reflect technological changes. Standards contain established knowledge as well as agreement on wider applications.

3.2 Types of standards

Standards of various origin, content, range of application and complexity are used in the design of products and their components. Standards are the indispensable foundation and prerequisite for all types of design work. In the design process, designers have to follow standards at differing levels according to the market they are targeting.
The standards used in design can be classified by their origin as follows:

- national standards (e.g. BSI British Standards Institution)
- regional standards (e.g. CEN European Standards)
- international standards (ISO International Organization for Standardization)

The standards used in design can also be classified by content into: communication standards, planning standards, dimensional standards, material standards, surface standards, test standards, safety standards, etc. In addition to external standards, designers can use internal company standards in designs. In this context, the designer can use parts catalogues for in-house and bought-out parts,

rules and regulations for calculation and embodiment design and regulations for quality control, etc. Company standards are developed or selected for specific products while national and international standards are more generally applicable.

3.3 Preparing and using standards (Pahl & Beitz, 1996, p.352-355)

Searching for and using standards during the design process requires considerable effort. There are various sources from which information about standards can be obtained: folders with standards, BSI, ISO and other standards organizations' handbooks and guides as well as computer databases. Presently there is a trend towards integrating databases into CAD systems.
National and international standards are widely treated as regulations. Adherence to these standards is of great advantage in the case of legal disputes. In addition, all company standard should be considered binding within their sphere of application.
The use of standards should be examined against the following:

- Function: The designer should check if the anticipated overall function or subfunction can be fulfilled by the use of a standard solution. If it is not possible, the requirement list and the function structure should be re-examined before searching for a solution.
- Working principle: The designer can look at the possibilities of using existing standards in developing suitable solution principles or concepts.
- Layout: The basic and special standards - constructional, dimensional, material and safety - must be taken into account.
- Safety: Working and environmental safety standards must be observed.
- Ergonomics: The designer should follow the relevant literature to observe the standards required to ensure convenience and safety for the user.
- Production: The production standards and factory regulations should be observed by the designer.
- Quality control: Test standards and inspection rules should be considered in the design stage.
- Transport: Transport inside as well as outside the factory should be safe, simple and economical.
- Operations: Standard operations procedures for the product and operating symbols should be considered.
- Maintenance: Standard maintenance procedures should be considered in the design.
- Recycling: Disposal and recycling procedures should be taken into account.
- Cost: Cost and delivery time must be minimized with the help of standards.

3.4 Developing standards (Pahl & Beitz, 1996, p.352-355)

Designers can play a leading role in the revision of existing standards and the development of new standards. Such revisions and development should be technically and economically justified. Any standards developed can be assessed against the evaluation criteria to check their validity. The following principles can be used in developing the general and particularly the company standards in product design.
The envisaged standards must:

- comply with the state of the art in technology
- be accepted by the experts in the field
- ensure the interchangeability of the part
- be economical and useful
- provide a simple, clear and safe solution
- not conflict with the law
- not formulate design and production details
- not hinder technical progress and not deal with rapidly developing topics
- not be subjective
- not standardize fashion and taste
- not endanger safety

4 Standards in product documentation

4.1 Types of product documents

Once the product has been designed, its relevant details should be communicated to the other phases of the product life-cycle. The product details that are most important for manufacturing and product design are communicated through production and assembly drawings. The production details of each component should be documented so that it can be manufactured according to the required specifications. Thus the production drawings should include the material, dimensions & tolerances, surface properties, etc. Then the designer should communicate the product architecture. This purpose is fulfilled by the assembly drawing. The assembly drawing and related documents should specify the spatial arrangements of the various components, interfaces, etc. In addition to manufacturing information, product documents should also provide information for operation and maintenance. Operating and maintenance manuals should be prepared by the designer to satisfy this requirement. In certain situations, the designer should provide product information on handling, transporting, storage and disposal.

4.2 Using standards in product documentation

In preparing the product documents mentioned above, the designer should follow the standard formats, notations and symbols. These documentation standards act as a common language between the designer and different parties such as manufacturers, users and logistics providers.
The designer can use national or international standards for product documentation. It is common to use ISO or BSI standards especially in technical designs. Product documentation standards cover the following aspects:

- Engineering flow diagrams
- Representation of engineering components
- Lettering
- Units/quantities
- Tolerance
- Geometric product specifications
- Handling of computer-based information
- Metrology

5 Standardization as a strategy in product design

5.1 Variety and standardization

Globalization of the market, rapid technological change and diverse customer requirements have led manufacturing companies to produce a variety of products. They can no longer follow the strategy employed by Henry Ford in his model T - that is capturing market share and high profit by manufacturing large volumes of a standardized product. However, variety creates additional complexities and costs in manufacturing, and hence manufacturers have to find the proper balance between variety and standardization. Standardization is used as a strategy in product design by many companies to enhance the competitiveness of their products. This section discusses the necessity of standardization as a product design strategy.

5.2 Reasons for product variety

Product variety is the set of all products and items that a particular company offers to its customers. Product variety may have a certain breadth, length, depth and consistency. The breadth refers to the number of product lines offered by the company; the length to its total number of items; and the depth,

to the number of variants offered of each product in each line. Consistency of the product mix refers to how closely related the various product lines are in their end use, production requirements, distribution channels or in other criteria. Diverse customer requirements, increased globalization and rapid technological change are common phenomena experienced by today's manufacturing enterprises. Increased product proliferation is an inevitable consequence in such an environment. Shorter product life, shorter runs, and more customer specials have become common characteristics of the present manufacturing world. Product proliferation is unavoidable in a global market. Different markets may have different requirements for products, due to differences in taste, language, geographical, environment or government regulation. Popular marketing guru Philip Kotler points out that the product attributes vary with customer requirements. He identifies four reasons for variations of customer requirements, (Kotler, 1994)

i. Geographic reasons: region, country, size, city, climate
ii. Demographic reasons: age, sex, family size, income, occupation, education, religion
iii. Psychographic reasons: social class, lifestyle, personality
iv. Behaviouristic reasons: purchase occasion, user status, usage rate, benefits

Under the above situation two types of product variety can be identified: product variety at a specific time and product variety with time.

5.3 Bases for product differentiation

Product differentiation is unavoidable in satisfying diverse markets. The physical attributes of a product require differentiation depending on the target market.
There are several bases for differentiating a physical product as follows:

- Features: Features are the characteristics that supplement the product's basic functioning. The manufacturer can create additional versions by adding different features. For example, an automobile manufacturer can offer optional features such as power shutters, power steering, air conditioning, etc. The manufacturer should make a strategic decision as to which features should be standardized and which features should be optional.
- Performance: Performance refers to how the product's primary characteristics operate. For example a computer can be differentiated on the basis of processing speed and memory capacity.
- Conformance: Conformance is the degree to which a product's design and operating characteristics come close to the target standards. In other words,

this is called conformance to specification, which is closely related with the quality of the product.
- Durability: Durability is a measure of the product's expected operating life. Usually buyers expect to pay more for a more durable product.
- Reliability: Reliability is a measure of improbability that a product will malfunction or fail within a specified time period.
- Style: Style describes how good the product looks and feels to the buyer. Size, shape, aesthetic appearance and some other attributes affect the style of the product. A strong style does not necessarily promise high performance and high durability.

Apart from the above bases for product differentiation, characteristics such as input/output voltage, material, etc. have to be differentiated depending on the target market. For example, electrical items targeted for the European and American markets have to be differentiated on the basis of input voltage.

5.4 Problems associated with product variety

How product variety affects the manufacturing performance and competitive priorities is an important question. Many studies point out that product variety increases the unit cost of a product. Manufacturing costs can be divided into two categories: those depending on volume or scale and those driven by variety. The former decreases as volume increases. The later is proportional to the manufacturing complexity and includes set-up, material handling, inventory and other overhead costs. As variety increases, variety-related cost increases. Product variety creates a major operational challenge to managers of manufacturing enterprises because it is difficult to forecast demand accurately, leading to high inventory investment and poor customer service. Product and part variety increases the queue delays and work in process inventories. As product variety increases, assembly line balancing becomes more problematic and parts planning and production scheduling systems become increasingly complex. Generally it can be seen that product variety reduces the performance of manufacturing system cost, delivery, system utilization, etc.

5.5 Need for a balance between standardization and variety

As discussed above, variety creates many problems in the manufacturing system, reducing its performance. One problem faced by manufacturers is how to offer the variety demanded by the customer and a high level of performance. Among the various strategies, standardization can be used as a proactive strategy which aims to reduce the variety explosion in product and/or

component level while meeting customer needs. Common standardization strategies used in product design include size range, component commonality, modularity, platform concept, and delayed differentiation (postponement). The next sections discuss how these strategies are used in product design.

6 Size range (Pahl & Beitz, 1996, p.405-433)

6.1 Concept of size range

In delivering the product to the customers, there are two extreme approaches: to deliver one or a few product sizes to all customers or to deliver unrestricted sizes. An in-between option is to offer products in a preferred size range which establishes a balance between standardization and variety.

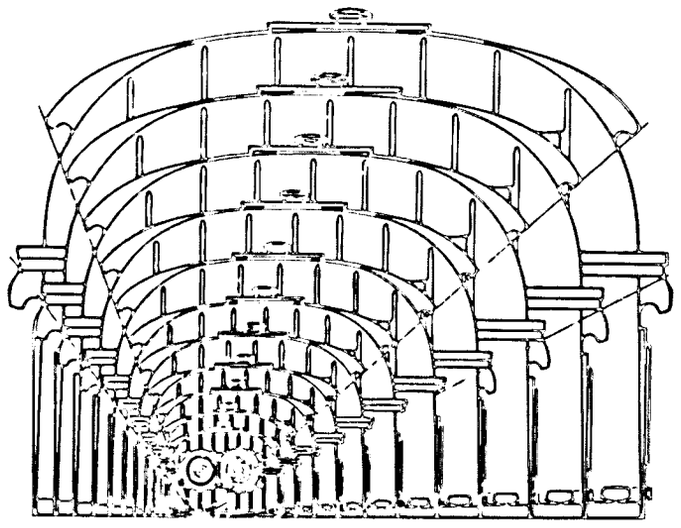


Figure: Display of a gear box size range (Source: Pahl & Beitz, 1996 p. 418)

In this approach, the designer selects preferred sizes for the product based on certain rules. Often the same technology is used for all the products. If, in addition to the range of sizes, other associated functions have to be implemented, then modular products (Section 7) will have to be developed side by side with the size ranges. The initial size of the product is referred to as the basic design and derived sizes as the sequential design.

6.2 Advantages of size range

Size ranges provide rationalization of design and manufacturing process. Both manufacturer and user can expect advantages in this strategy. Size range gives the following advantages:

- The design work can be performed once and modified for different levels of the size range.
- Production for the different ranges can be repeated in batches and hence becomes cost-effective.
- Higher quality.
- Shorter delivery times.
- Easy acquisition and replacement of parts by user.

6.3 Disadvantages of size range

In spite of a number of advantages, the size range approach in product design has certain disadvantages for both manufacturer and user. Size ranges have the following disadvantages:

- Size range limits the customer's choice of size compared with total customization.
- Since it tries to meet different customer needs in a single product, the design might not have the optimal operational properties.
- Unavailability of the exact sizes will reduce the manufacturer's sales.

6.4 Size range design

In size range design, products are designed to a limited number of sizes by making use of a decimal-geometric preferred number series. Usually product parameters are magnified by a constant factor to determine the next step of the product. Generic tools used for developing size ranges are discussed in the following sections.

6.4.1 Similarity laws

Geometric similarity ensures the simplicity and clarity of the design. Geometric magnification of the product parameters is only allowed when similarity laws permit. The similarity principle can be used in design if the relationship of at least one physical quantity in the basic design and sequential design is

constant. Basic similarities can be defined with the help of the fundamental quantities of length, time, force, electrical charge, temperature and luminous intensity. *Geometric similarity* exists if the ratio of all the lengths of any sequential design to all the lengths of basic design is constant. Here, the non-dimensional parameter, φ_L, to be held constant is determined as follows:

$$\varphi_L = L_1/L_o$$

Where, L_1 = any length of the first member of the size range (sequential design)

L_o = corresponding length of the basic design

The k^{th} sequential design magnification factor can be found as $\varphi_{Lk} = \varphi_L^k$

Similar to geometric similarity, similarities for time, force, electricity, temperature and luminous intensity can be described. Other relations may be defined if a constant proportionality exists between two or more of the basic quantities. In the case of simultaneous invariance of length and time, there is kinematic similarity; and in the case of simultaneous invariance of length and force, there is dynamic similarity.

6.4.2 Decimal-geometric preferred number series

Once important similarity relationships are understood, the next step is to determine the best method of choosing the individual steps of size range. The decimal-geometric series is one of the popular methods. A decimal-geometric series is based on multiplication by a constant factor φ and is developed within one decade. The constant factor φ determines the step sizes of the series and can be expressed as:

$$\varphi = \sqrt[10]{10} = 1.25$$

Where, n is the number of steps within the range
a_n is the greatest term of the range
a_0 is the smallest term of the range
A decimal-geometric series takes N = 10
For 10 steps the series would have a factor: $\varphi = \sqrt[10]{10} = 1.25$
A 10-step series is called an R10 series.

For a 20-step series (R 20 series) $\varphi = \sqrt[20]{10} = 1.12$

6.4.3 Selection of step sizes

The selection of optimum step sizes involves an integrated approach by considering market, design, production and sales. The following information is useful in deciding on the optimum step sizes.

Basic series			
R5	R10	R20	R40
1.00	1.00	1.00	1.00
			1.06
		1.12	1.12
			1.18
	1.25	1.25	1.25
			1.32
		1.40	1.40
			1.50
1.60	1.60	1.60	1.60
			1.70
		1.80	1.80
			1.90
	2.00	2.00	2.00
			2.12
		2.24	2.24
			2.36
2.50	2.50	2.50	2.50
			2.65
		2.80	2.80
			3.00

Basic series			
R5	R10	R20	R40
	3.15	3.15	3.15
			3.35
		3.55	3.55
			3.75
4.00	4.00	4.00	4.00
			4.25
		4.50	4.50
			4.75
	5.00	5.00	5.00
			5.30
		5.60	5.60
			6.00
	6.30	6.30	6.30
			6.70
		7.10	7.10
			7.50
	8.00	8.00	8.00
			8.50
		9.00	9.00
			9.50

Figure: Main values of four preferred number series (Source: Pahl & Beitz, 1996, p. 410)

- Market expectations in respect of individual sizes
- Market behaviour in respect of simplified ranges and resulting gaps
- Production cost and times of the various step sizes and effect on the overall production cost
- Properties of each product in size range

Since the optimum selection of step sizes must be based on the above factors mentioned, it is not always possible to opt for a constant step factor. Often technical and economic considerations will demand the breakup of a particular range of sizes into several sets.

The range can be split up by means of a constant or a variable factor. Different types of size ranges can be identified as follows:

- Type A has a constant factor (for instance φ =1.25 corresponding to R 10) over the entire range.
- Type B has both coarse and fine gradings; the lower part of the range is divided up coarsely (for instance φ =1.6 corresponding to R 5) and the upper part more finely (for instance φ =1.25 corresponding to R 10). This is suitable whenever a coarse grading for the smaller product sizes is economically justified.
- Type C has a greater increment in the upper range and is used if demand is concentrated for smaller sizes.
- Type D has smaller step factor in the middle part of the range.
- Type E has larger step factor in the middle part of the range.

7 Component commonality

7.1 Concept of component commonality

Component commonality can be considered as one of the most basic ways of reducing the complexity caused by product variety. The general idea of component commonality is to replace various different components by one standardized component. This is also referred to as component standardization. Under component commonality, customer variety is satisfied while reducing the complexity through reduction of part variety.
There are three possible situations of component commonality,

i. Component commonality among products
ii. Component commonality within a product
iii. Component commonality among product generations

Component commonality in car design

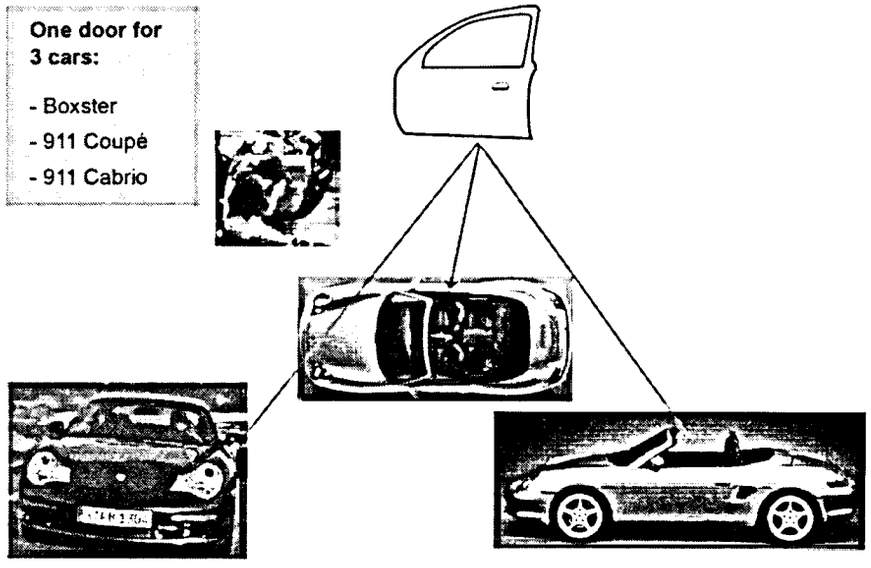


Figure: Component commonality in car design (© Hesser)

7.1.1 Component commonality among products

Several components in different products are replaced by a common component that can perform the functions of all the replaced components.

Example:

Electrical products produced for the European market and the US market need two different power supplies - 110V & 220V. These two power supply units can be replaced by one universal power supply which satisfies the requirements of both markets. Another possible strategy of component commonality is that a standardized component is used in many different products that have the same functional requirement. However, variety is provided by differentiating a few other components.

Examples:

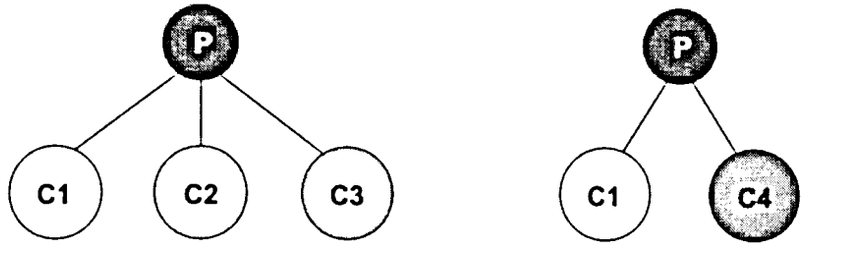
A standardized machine is used with different dials to create a variety of watches.

A standardized door is used for different car models.

7.1.2 Component commonality within a product

Several components in a product are replaced by a common component that satisfies the requirements of all the replaced components.

Component commonality within a product



(a) Product with unique components

(b) Product with common component (C2 and C3 are replaced by C4)

Figure: Component commonality within a product (© Perera)

Example:

Two bolts subjected to two different stress levels in the same product are usually selected in two diameters. But these two sizes can be replaced by the bolt with larger diameter which withstands both stress levels. This approach is applicable in many engineering products where standardized nuts and bolts, shafts, bearings, etc. can be used.

7.1.3 Component commonality among product generations

Common components are used in different products or in upgraded products across the time frame. This approach helps manufactures to introduce frequently upgraded products and reduce the development cost. This concept can be easily implemented with the modularity concept discussed in Section 8.

Example:

Upgraded versions of motor vehicles use many components such as wheels, gear boxes, valves and steering from the previous version of the vehicle. Only few components are changed in the upgraded model and many components are common to the previous and new generations.

7.2 Advantages of component commonality

Advantages of component commonality are widely discussed by many researchers and practitioners. Component commonality produces advantages in all stages of the product life-cycle: product development, manufacturing, distribution, usage, and disposal/recycling, as follows:

Product development:

- Reduces cost and time, avoiding duplication effort
- Reduces cost of database management and can ensure accelerated and accurate part information retrieval
- Rapid introduction of upgraded version of the products

Manufacturing:

- Economies of scale
- Reduces complexities in manufacturing
- Reduces material and equipment costs
- Increases level of automation
- Reduces labour cost
- Reduces WIP and inventory costs
- Reduces setup and changeover costs

Distribution:

- Reduces inventory at distribution centres
- Reduces transportation cost

Usage:

- Reduces maintenance cost
- Reduces spare parts inventory
- Reduces number of backups

Recycling / Disposal:

- Reduces time and costs of retrieval, separation, identification and reprocessing
- Increases price of remarketing

7.3 Disadvantages of component commonality

It should be pointed out that adequate caution needs to be exercised in opting for component commonality, as it may also have some disadvantages. The common components may have excess functionality since they are intended to satisfy the requirements of all the products in which they replace components. Thus, commonality may increase the volume, weight and cost of the component. Excess functionality of the components may lead to increased power consumption in the usage phase resulting in high operational costs.
Customer preference for certain attributes of a product varies with the market. When the common components are designed for multiple markets, design should consider the trade-off among the customer preferences. In some situations, therefore, customer dissatisfaction is, to a certain extent, unavoidable.

7.4 Component commonality design

Common components should be designed to satisfy the requirements of the products they serve. In other words, the common component should possess the functionalities of the unique components which it replaces. In satisfying these multiple requirements, the common component may have excess functionality and may be costlier than the unique components. Thus in making the final decision about commonality, the designer should evaluate the cost increase and other benefits such as inventory savings, economies of scale, etc. In addition, the increase in operating costs due to the excess functionality resulting from commonality should be considered in the final decision. The following shows practical design examples of component commonality and approaches in making a commonality decision.

Example 1: Wire harness problem (Source: Thonemann, U.W. and Brandeau, M.L., 1997)
A German automobile manufacturer used 136 unique wire harnesses in its different engines. Thus, wire harness manufacturing had to produce 136 different variants in relatively small lot sizes. Due to the high level of variety in the wire harnesses the manufacturer faced additional complexities in many areas such as accounting, inventory control and production control. The manufacturer decided to reduce the variety in wire harnesses by incorporating additional functionality in some of them. However, the exact number of wire harnesses to use and the set of features to include in each wire harness needed to be determined. There are a number of possible combinations and different degrees of commonality. The problem can be formulated as a mathematical programming problem. There are possible options for combining the features. The objective of the model is to reduce the total cost which comprises the production cost (increases with set of features in the variant), inventory holding cost, order cost

and complexity cost (the latter three decrease with a reduction in variety), As constraints, each combination (variant of wire harness) should satisfy the requirement of the product it serves.

Example 2: Component commonality in sanitary fittings (Source: Perera, H.S.C., Nagarur, N.N., & Tabucanon, M.T., 2000).
An Asian sanitary fittings manufacturer is considering implementing component commonality in two sister products namely a single-lever faucet and a single-lever shower. Each product has a number of series, models and options such that the single-lever faucet has 16 variants and the single-lever shower has 26 variants. The component called the cartridge, used for mixing hot and cold water, is a possible candidate for commonality and accounts for 28-31% of the cost of the single-lever faucet and 18-21% of the single-lever shower. At present the company uses 4 variants of cartridge, which are purchased from external suppliers. Technical and market analysis shows that a common cartridge can be used for variants 1 & 2 and variants 3 & 4. In other words, for variants 1 and 2 either variant 1 or 2 can be used and for variants 3 and 4 either variant 3 or 4 can be used. Now the problem faced by the decision-maker is whether the use of a common component is economical and, if it is economical, which of the variants should be selected as the common component. When a decision is made on component commonality, three basic costs are considered: periodic costs, modification and reconfiguration costs, and assembly cost saving. Periodic costs consist of purchase cost, order cost, transport cost, cycle inventory cost and safety stock cost. Modification and reconfiguration costs include the one-time cost of redesigning the product to use a common component and the cost of modifying the existing tools. Due to the reduction in part variety (less complexity), savings in the assembly cost are also considered. For each possible option, i.e. without commonality, with commonality using different variants of cartridge, the total cost is evaluated to make a final decision.

8 Modularity

8.1 Concept of modularity

Most products - a great variety of assembled products and software - consist of several functions that, when combined together, provide the overall function of the product. The architecture of the product may be modular or integral. In a modular design approach, designers create a new product design by decomposing the overall functionality into a set of interrelated functional modules. The opposite of modular design is integral design where many functionalities are integrated into a single element. Decomposing a product design into functional

modules and specifying the interfaces that define the functional relationships between those modules creates the product architecture.
Module interface specification defines:

- how one module may be physically connected to another (attachment interface)
- how power is to be transferred between modules (transfer interface)
- how signals will be exchanged between modules (control and communication interfaces)
- what spatial location and volume the modules occupy (spatial interfaces)
- various ways in which the functioning of one module may generate heat, magnetic fields or other environmental effects that must be absorbed by other modules (environmental interface)

8.2 Conventional versus modular product design

A conventional product design process tries to determine the specific characteristic of a product that will appeal most broadly to some identified set of customers. The objective of the product designer is to create an optimal product design that provides the desired product design attributes at the lowest possible cost or the highest possible level of performance for a given cost constraint. The outcome of a conventional, optimizing product design process is a complex product architecture that typically includes assemblies of components that have been integrated to improve performance or lower cost. Both during and after development, changing a component design is likely to be time-consuming and costly, because changes to one component may require compensating changes in the designs of many interrelated components. In contrast to the high degree of interdependence among component designs typical of an optimized product architecture, modular product design minimizes the interdependencies between component designs in product design. Modular design achieves this by specifying interfaces between components to allow ranges of variations in component design. Modular product architecture is defined intentionally at the beginning of a development process to allow for the substitution of different versions of components (modules) in order to create product variations with different bundles of functionalities, features, and performance levels.

8.3 Advantages of modularity

The modular approach provides advantages in different competitive dimensions. Thus many manufactures use modularity as a strategy for enhancing competitiveness. The advantages of modularity can be outlined as follows:

Greater product variety:
Modular architecture permits product variety by mixing and matching different combinations of functional modules.

Example:
A desktop computer can be configured in a great number of variations by substituting microprocessors of different speeds, hard disk drives and memories of different capacities and varieties of monitor, keyboards, modems and other devices. However, some of the combinations of modules are not very attractive or practical.

Shortening time to market:
Modular product architecture facilitates the development of modules simultaneously. Simultaneous development reduces the time to market of the product.

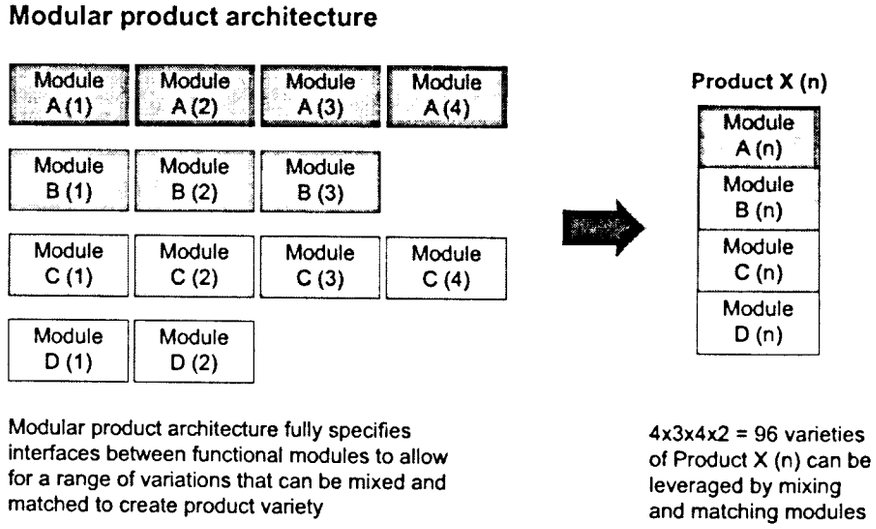


Figure: Modular product architecture allows leveraging of product variety
(Source: Sanchez, 1996, with modifications)

Faster introduction of improved products:
The ability to introduce components (modules) with improved performance into a modular product design (while reusing other modules) enables the rapid introduction of upgraded product models as soon as improved modules become available.

Lower cost:
Modular product design can lead to lower costs for the design, manufacture, distribution and servicing of products. Compared with creating a number of conventional product designs, creating a single modular product that allows leveraging of several product variants reduces the design cost. Standard modules can be shared by many product variants and hence component commonality can be implemented through modularity. Therefore many of the advantages described for component commonality (Section 7.2) can be achieved in modular designs. Modularizing product designs may allow fundamental changes in service requirements. Canon's modularization of components in its compact personal copier design allowed it to introduce the concept of a cartridge module that customers can easily replace themselves, allowing Canon to overcome

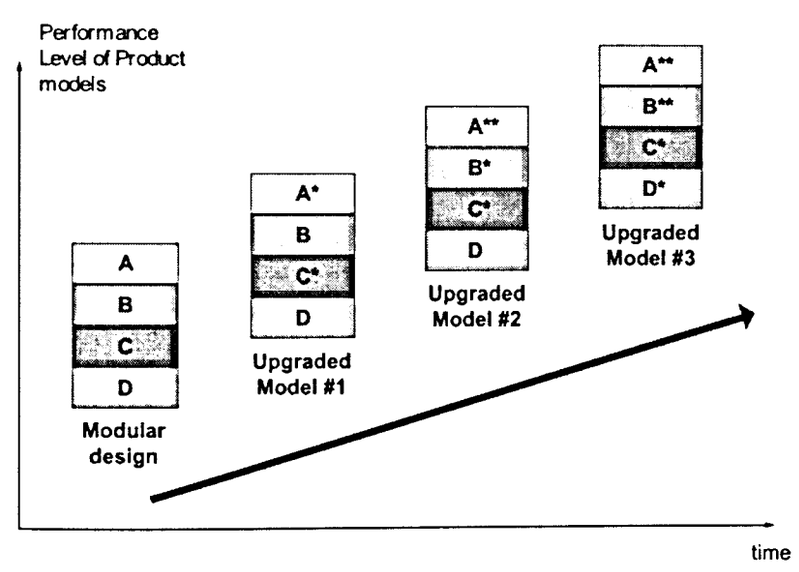


Figure: Component-based upgradeability of modular product design
(Source: Sanchez, 1996, with modifications)

the entry barrier posed by Xerox's extensive service network. Manufacturers of copiers, computers, and many other kinds of equipment are now converting to product designs with self-diagnostic capabilities and easily replaced modular components to radically reduce field service cost.

Improved ability of technology development:
Modular product design intentionally decouples technology development from product development. Fully specifying the component interfaces in modular product architecture requires a well-developed understanding of the basic technologies used in each component module and how these modules interact in product architecture. The technologies are therefore well-understood and decoupled at the time development begins. Hence modular product design based on decoupled technology and product development improves the capacity for technological development at the component level.

Distributed product development and manufacturing:
Fully specifying the module interfaces and defining the functional requirement of each module at the outset improves the ability of a product designing firm to distribute module development tasks to groups within its internal network of resources or most capable module development firms. This can reduce the time to market of a product.
In addition to design, modular architecture facilitates the manufacturing of independent modules at different manufacturing facilities. Manufacturing a few modules in a plant enables manufactures to master these few modules and provide better-quality products.

8.4 Disadvantages of modularity

While providing several advantages, modular design has the following limitations:

- Adaptations of special preferences are not as they are with individual design.
- Rare combinations needed to implement unusual requirements may prove much costlier than tailor-made designs.
- Production costs are increased, for example, because of accurate locating surfaces and additional interfaces.
- Increased assembly effort is required.
- Weights and structural volumes of modular products are usually greater than those of specially designed products.

8.5 Modular product development

Modular product design approach consists of following steps (Pahl & Beitz, 1996).

Clarifying the task:
Designers must first identify the various tasks to be performed by the product. A characteristic demand of the modular system is that it must fulfil variants of overall function. Information on market expectations and the demands of particular variants should be gathered. Whenever the implementation of rarely demanded variants increases the overall costs of the modular system, an attempt must be made to remove such variants.

Establishing function structures:
The establishment of function structures is of particular importance in the development of modular systems. From the beginning, designers must try to subdivide the overall function variants into a minimum number of similar and recurring sub-functions. The function structures of the overall function variants must be logically and physically compatible, and the sub-functions determined by them must be interchangeable. In dividing the overall function into sub-functions designers should try to achieve overall function by the combination of a minimum number of easily implementable basic functions for high demand variants and more rarely demanded product variants additional special functions. In this stage it is also essential to identify the interface requirements between different basic sub-functions.

Searching for solution principles and concept variants:
After the overall function has been divided into sub-functions, the next step is to find the solution principles for the implementation of the various sub-functions. The designers should look at providing module variants without changes in working principle and basic design. If interfaces are clearly defined between the modules, the designers can independently design each module.

Selecting and evaluating:
If several concept variants could be found in the previous step, each must now be evaluated with help of technical and economic criteria in order to select the most favourable solution concept. Apart from the determination of the technical rating of individual concept variants, economic factors are of crucial importance in the design of modular systems.

Module design:
After selecting the solution concept, individual modules must be designed to satisfy the functional and production requirements. Designers must try to provide basic, auxiliary, special and adaptive modules (based on basic function, auxiliary function, special function and adaptive function) with the maximum

number of similar and recurring parts. When selecting step sizes, designers should aim at the optimum resolution of modules.

9 Platform design

9.1 Concept of platform

A platform can be defined as a set of assets which are shared by a set of products. The assets can be divided into four categories: component, process, knowledge and people. From the product design perspective, the platform is the centre of a product family. A platform applies to a product range in which all products have certain constituting elements in common. These elements form a common platform for all end products within the product family. The basic difference between component commonality and the platform is that in the case of component commonality all products do not necessarily use the same components whereas a platform is the same for the whole family.

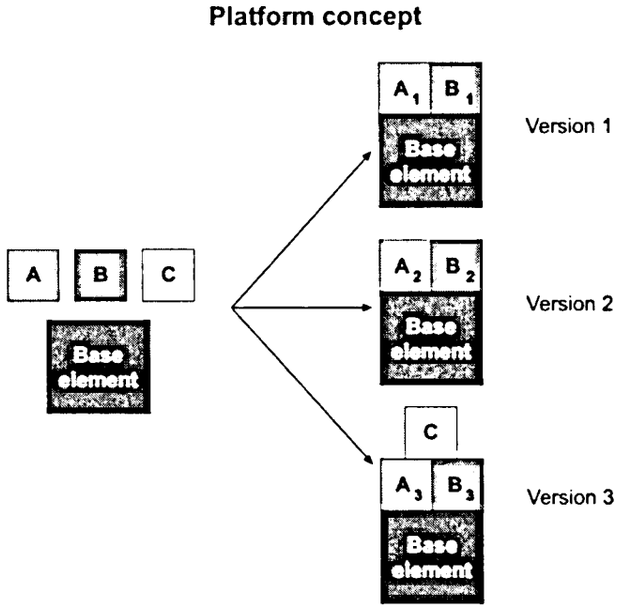


Figure: Platform concept (© Perera)

9.2 Advantages of platform design

The platform approach can reduce the product development time and cost. Since a base element is used commonly across the product family, the benefits discussed under component commonality are applicable here.

9.3 Disadvantages of platform design

Since the base element (platform) should satisfy the requirements of the pro-duct family, the base element may have excess functionality. Thus it may need additional development and manufacturing costs per unit. However, these cost increases can be offset by a reduction in duplicated effort in development and other types of cost saving, such as inventory cost. Another disadvantage of a platform product is a reduction in the distinctiveness of each product.

9.4 Product design using platform

In employing the platform concept, the designer should identify the functionalities and features of the product for which customers do not demand any differentiation. These functionalities and features are included in the platform (base element) and the functionalities and features that need differentiation to create the variety should be added to the platform at a later stage.

Example 1: Platform-sharing pays off for Volvo S40 and Mazda3 (Source: Advertising Age, 4/11/2005, Vol. 76 Issue 15).
Ford Motor created two very different vehicles with the Mazda3 and second-generation Volvo S40, which share the same basic Volvo *platform*. The two products are differentiated by changing components such as the interior, grille, light, etc.

Example 2: Preparing for the future of chip design (Source: Electronic Business; 12/1/2004, Vol. 30 Issue 12).
The future of Electronic Design Automation (EDA) depends on standardized customizable chips that will allow system designers to define chip functionality at the software level. The platforms will be a combination of processors and customizable logic that can be compiled into performing a variety of functions.

10 Postponement

10.1 Concept of postponement

Postponement is a strategy to achieve customization by a process-based and a product-based approach. In postponement strategy, product and process are designed with the aim of shifting the differentiating point as much as possible towards the customer. A product remains generic up to the differentiating point and is then customized. Here the idea is to delay the customization as late as possible in the supply chain. Postponement is also referred to as delayed differentiation.

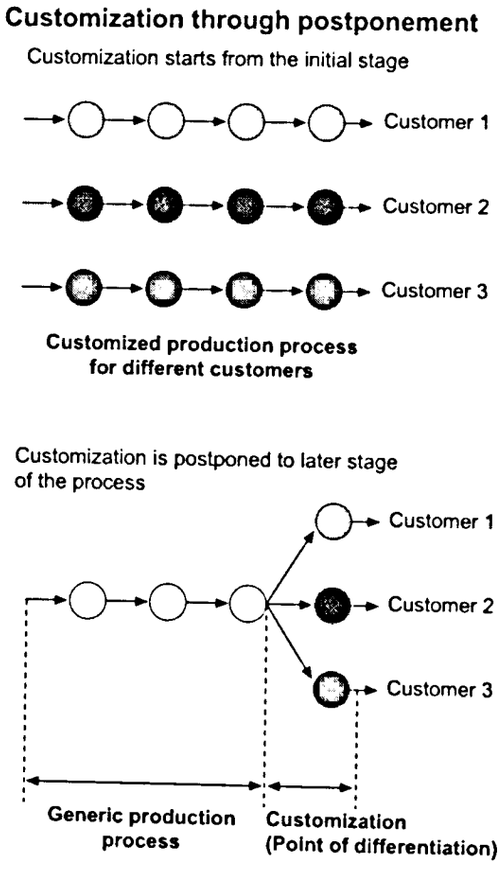


Figure: Customization through postponement (© Perera)

10.2 Advantages of postponement

Postponement allows both a quick response and customization. Since the product is designed so that it can be differentiated at later stage of the supply chain, the generic product can be made-to-stock and then customized on receipt of the customer order. This approach can either reduce the customer lead-time or reduce the inventory level through risk pooling. Further cost reductions can be achieved through economies of scale in the process before the differentiating point.

10.3 Disadvantages of postponement

It might need additional investment to redesign the process and product. Since the generic product should support all the end products, there may be excess functionality in the generic product.

10.4 Design for postponement

Process and product should be designed so that there is a generic product up to the differentiation point. Postponement strategy can be effectively implemented with the component-commonality, modularity and platform approaches, together with process restructuring. The following examples discuss the different approaches in postponement.

Example 1: Postponement through component commonality (Lee, 1996).
This example considers a computer manufacturer that manufactures two types of printers: black-ink (mono) and multicolour-ink (colour) printers. The manufacturing process of the two printers consists of three major steps: printed circuit board assembly (PCA), final assembly and test (FA&T) and final customization for different versions. At each step, different components are used for different end products. Hence the manufacture of mono and colour printers can be viewed as two distinct processes. Postponement can be achieved by either standardizing the PCA stage, or standardizing both the PCA and FA&T stages. Standardizing the PCA stage requires standardization of a key component, i.e. common head driver board for both the mono and the colour printers. The common head driver board demands additional development costs and unit costs due to technical difficulties. Standardizing the FA&T stage requires the standardization of a key component in that stage, i.e. a common printer mechanism interface for both printers. This is a relatively simple task and benefits can be achieved with a slightly higher cost. In the above situation, due to the additional cost of common components, the designer should evaluate

the benefits of inventory savings and economies of scale against increase unit cost in making the postponement decision. It is also necessary to identify the optimum differentiation point by evaluating the costs and savings. Postponement strategy can be usefully employed by having a high degree of component commonality at the beginning of the assembly process. The process and product should be designed so that the common components are assembled in the early assembly process.

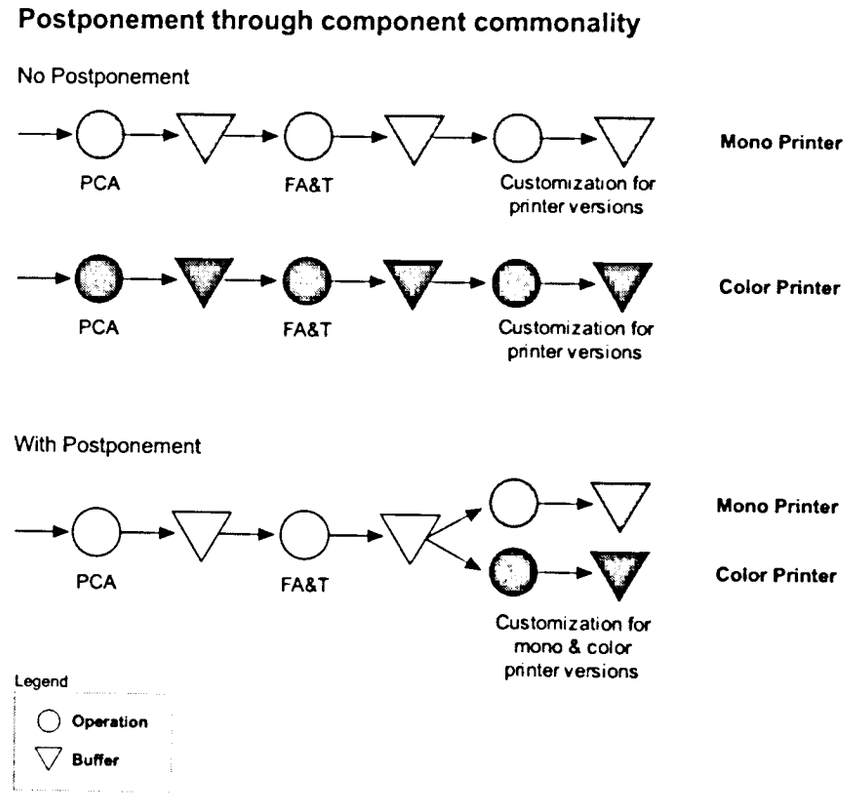


Figure: Postponement through component commonality (Source: Lee, 1996)

Example 2: Postponement through modular design (Lee, 1996).
This example considers a case in which a manufacturer produces different colours of dishwashers. The manufacturing process consists of four major steps: i. fabrication; ii. integration; iii. shipping; and iv. distribution. Basic components such as motors, circuit boards, racks, plastic parts, chassis and metal frames with different colours are produced during the fabrication stage. In the integration stage the above basic components are assembled. Afterwards, the finished dishwashers are shipped to the distributors and then they are distributed to the sellers. Because metal frames are assembled in the second stage, the dishwashers are differentiated after the first stage. The distribution centres have to keep adequate stocks of dishwashers in different colours in order to satisfy the different colour requirements of the downstream supply chain. Differentiation can be postponed to distribution by modular design of the metal frames. Metal frames can be divided into two modules: a generic metal frame, and a plastic panel that specifies the colour of the dishwasher. With this modular design, the manufacturer would produce and ship a generic dishwasher without plastic panels. Plastic panels are shipped to distribution centres separately and are held in the distribution centres. The distribution centres are responsible for inserting the plastic panels in the generic dishwashers to specify the colour of each dishwasher. In this case allowing distribution centres to handle an additional operation enables the point of differentiation to be delayed to the distribution stage. Dividing the metal frame into a generic metal frame and plastic panel means that there is an additional cost associated with the plastic panel. Assembly of the plastic panel at the distribution centre also causes additional cost. Since the distribution centre does not have to keep dishwashers in different colours, there is substantial reduction of inventory holding cost. Therefore, in making the decision on postponement, the increased cost of plastic panel and additional assembly operations should be considered against the inventory savings. It is possible to have multiple differentiation points as illustrated in the following example.

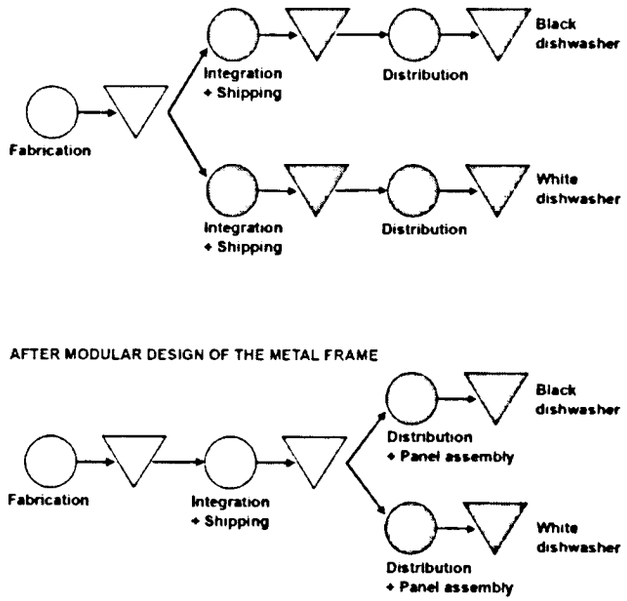


Figure: Postponement through modular design (Source: Lee, 1996)

Example 3: Watch manufacturing with multiple differentiation points (Garg & Tang, 1997)
This example considers a watch manufacturer selling sport and dress watches for men and women. The process starts with a generic mechanism that is customized into dress and sports models by adding certain model-specific components such as integrated circuits. Each model is then customized into a man's or woman's watch by assembling the mechanism into different types of casing.

11 Approach for analysing standardization opportunties

The above sections (7-10) discuss different approaches to standardization. The problem faced by the designer is when and how to use these approaches. Standardization opportunities can be analysed using two approaches: a top-down approach and a bottom-up approach.
In the top-down approach standardization opportunities are identified by analysing the product. The designer can decide the size range at the product level. Once the product variants have been decided, possibilities for modular architecture can be analysed together with component commonality. Concurrent product and process designs should be prepared in order to implement postponement since postponement needs commonality in both components and process during the early stages.
In the bottom-up approach components serving for different product variants can be studied to identify the standardization opportunities. Here the components which do not affect the spatial requirements and changes of other components can be analysed to implement commonality isolation with the product. Such opportunities are available for standardizing the components such as interfaces, attachments, etc. It is recommended that the hybrid approach should be adopted to identify standardization opportunities.

12 Concluding remarks

This module was intended to provide knowledge on how to use standardization as a strategy in product design. Readers were given an overall view of standardization strategies and were shown how individual strategies are used. In making the decision on standardization, the designers are expected to look at the evaluation criteria described in each selection. However, the author of the module has not discussed the complicated mathematical evaluations and models to avoid unnecessary complexities. Readers who wish to deepen their knowledge are advised to study the reference material listed. The examples described in this module show the present trends in employing standardization as a strategy in product design. These examples give readers some ideas on how standardization strategies could be practically employed in real products.
Product designers should select the correct standardization strategy according to the market and their operational environment. For this purpose, designers should have a sound knowledge of the marketing and operational aspects of the business other than product design.

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14 Glossary

Adaptive function
Adaptive functions are necessary for adaptation to other systems and to marginal conditions. They are implemented by adaptive modules whose dimensions are not fully fixed in advance and hence allow for unpredictable circumstances. Adaptive modules may be of the "essential" or the "possible" type. (Pahl & Beitz, 1996 p. 435)

Assembly line balancing
All the work stations of an assembly line should have an equal amount of work content in order to obtain maximum utilization of the workers and equipment. Building the assembly line with equal amounts of work content at each station is referred to as assembly line balancing.
(Pahl & Beitz, 1996 p. 435)

Auxiliary function
Auxiliary functions are implemented by locating or joining auxiliary modules that are kept in step with the basic modules and are usually of the 'essential' type.
(Pahl & Beitz, 1996 p. 435)

Basic function
Basic functions are fundamental to a system. They are not variable in principle. A basic function can fulfil an overall function simply or in combination with other functions. It is implemented in a basic module which may come in one or several sizes, stages and finishes. Basic modules are 'essential'.
(Pahl & Beitz, 1996 p. 435)

Complexity cost
A high degree of product variety causes complexities in planning and control of production systems. Due to these complexities there will be an additional cost in production. This cost is called the complexity cost.

Component commonality
Replacing two or more components by a common component, or using a common component across several products.

Customization
Preparing or altering the product or service according to the requirements of the customer.

Decoupled technologies
Technologies which are independent of each other.

Delayed differentiation
Delaying customization of the product to a later stage of the supply chain.

Design catalogues
Design catalogues are collections of known solutions to design problems.
(Pahl & Beitz, 1996 p.89)

Economic criteria
Profitability, return on investment, payback period, internal rate of return, etc.

Economies of scale
When products are produced in large volumes, there are some cost benefits due to larger production runs, bulk buying of raw materials, etc. The savings derived from this situation are known as economies of scale.

Environmental safety standards
Standards used to prevent damage to the environment

Excess functionality
Functionality of a product or component which is not required by the customer.

External standards
Standards developed by outside parties such as national standards, and international standards.

Factory regulations
Regulations employed to protect the workers and resources of a factory and to maintain the requirements of production

Function structure
Relation between overall function and subfunction, and relation between subfunctions.

Generic product
Product which is not customized for a specific customer.

Generic tools
Tools which are not specific and can be used for all applications.

Geometric product specification
Specification given for the product geometry such as roundness, cylindricity, flatness, etc.

Inspection rules
Rules followed in inspecting a product, e.g. type of test equipment, sample size, qualifications of inspector

Interchangeability
Ability of components of the same type to be exchanged with each other.

Inventory holding cost
Cost incurred in keeping items in the inventory. This includes capital cost, storage cost, etc.

Locating surface
Surface required for placing two elements in an accurate position.

Market behaviour
Market behaviour includes purchasing power, purchasing pattern and changes in customer taste in the market.

Market standards
Accepted standards of the market. Market standards can be based on national, regional or international standards. Sometimes market standards can change with the norms and beliefs of the customers in the market.

Mathematical programming
A method in mathematics to model and analyse real-world problems.

Metrology
The scientific study of measurement.

Modularity
Modularity represents the concept where overall function is divided into sub-functions and overall function is achieved by combining the elements which satisfy those subfunctions.

Operational cost
Costs incurred in using the product. This includes costs of energy, maintenance, etc.

Optimum step sizes
Step sizes of the product range that reduce the cost to the manufacturers, without dissatisfying the customer's variety requirement.

Order cost
Cost incurred in placing a purchase order. This includes the cost of preparing an order and other administrative costs.

Physical attributes
Physical attributes are the features or characteristics of a product that can be perceived/observed.

Product differentiation
Creating product variety to meet the different customer requirements.

Product family
Group of products with certain similarities.

Product layout
Product layout is the arrangement of components to give the final product; also referred to as product architecture.

Product life-cycle
Product life-cycle refers to the stages that the product passes through from product design to disposal/recycling. Stages in the product life-cycle are product design, manufacturing, distribution, usage and disposal/recycling.

Product proliferation
Increase in product variety to meet different customer requirements.

Product variant
A form or version of a product that varies from other forms of the same product.

Production standards
Standards to be observed to ensure the precision, reproducibility, tooling requirements, etc.

Regulation
A rule made by an authority. The authority may be a national regional, international or other form of body.

Risk pooling
Risk pooling refers to the situation where risk is shared among numbers of people or entities. In inventory control, risk pooling describes the following situation. When a common inventory supplies the demand for different markets, the possibility of one item going out of stock will reduce since demand in all the markets will not increase simultaneously; hence a common inventory can satisfy the demands of all the markets.

Sequential design
Design derived from the basic design by changing the parameters.

Size range
In the size range approach to design, designer provides the product in different step sizes within certain size ranges instead of providing sizes demanded by the customer.

Spatial arrangements
Spatial arrangements describe how various components of a product are located in space relative to each other.

Special functions
Special functions are complementary and task-specific subfunctions that need not appear in all functional variants. They are implemented by special modules of the 'possible' type.
(Pahl & Beitz, 1996 p. 435)

Structural volume
Space required by the product structure.

Supply chain
The supply chain represents the network of all the activities from supplying raw materials to delivering finished goods to the end user.

Technical criteria
Technical criteria are product concepts that should be evaluated such as availability of technology, feasibility of developing the product technology and acquisition of product technology.

Test standards
Conditions to be maintained in testin, e.g. temperature, pressure and sample size.

Tolerance
Allowable deviation of dimensions.

WIP
Work in process - work in process refers to the items which are being processed in the manufacturing plant.

Work in process
Work in process refers to the items which are being processed in the manufacturing plant.

Working structure
The combination of several working principles results in the working structure.

15 Key questions

- What is the difference between standards and standardization?
- What is the difference between conceptual and embodiment design?
- In product documentation, which type of standard is more suitable - a national standard, an international standard or an internal company standard?
- What are the common strategies for standardization?
- Does standardization always reduce the cost?
- Can standardization strategies be implemented together?
- What is the difference between a platform concept and component commonality?
- Does standardization only reduce manufacturing-related costs?
- Can standardization strategies be used to design services?

Wilfried Hesser[1]

Abstract

In-company standards are often regarded as minor boundary conditions when designing a new product. Often standardisation is only implemented after cost or complexity targets have already been missed. In fact, in-company standardisation can and must be part of corporate and competitive strategies right from the beginning of the product's design process to ensure business success. First a general introduction into the various concepts of strategy is presented and discussed on company and departmental level. Here the most common state-of-the-art approaches are described. In the following chapters in-company standards are evaluated in the context of the competitive strategies of cost leadership and differentiation based on Porter's approach and the derived functional strategies. The analysis concentrates on the departments of design and development, procurement and production. In this context the individual advantages and weaknesses of typical in-company standards are presented.

[1] Based on the final report for the European Union, "The advantage of standardisation as a management instrument in companies", Hesser & Hoops (2003), rearranged and revised for this teaching module by Hesser, W. & Stegemann, P.

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1 Preface

Today advancing globalisation is affecting more companies than ever, including an increasing number of companies which act only on a European or even national level. The growing competition is forcing companies to adapt their internal structures and processes to the dynamic competitive conditions. The selection and implementation of the right competitive strategy is the key to long-term company success. In-company standardisation offers numerous opportunities to support competitive strategies in a sustainable manner and therefore presents an efficient instrument to increase the company's competitiveness. This strategic potential of standardisation is illustrated in this teaching unit. The unit is structured as follows: first current typologies of competitive strategies are discussed with regard to their suitability for the following analysis. At the end of the second chapter functional strategies are derived which allow the competitive strategies to be implemented into actual detailing, planning and coordinating directives. In the third chapter the effect of different in-company standards on these functional strategies is analysed and summed up in a so-called optimum standardisation mix. Some concluding remarks and an outlook on the current research will finish this module.

2 The concept of strategy

In the academic literature there is hardly any expression for which one can find more definitions than for the term "strategy". Therefore in this chapter it is necessary to give an overview of the prevailing definitions and their relevance to the topic of in-company standardisation as a strategic management instrument. First, the different levels of strategy both on the market and on the company level are described. Then different concepts of corporate strategy are presented to give an overview of the state of the art in management research. From these concepts competitive strategies are derived (Section 2.3) and implemented into functional strategies (Section 2.4) which are the basis for the evaluation of in-company standardisation as a strategic instrument.

2.1 Strategy on different business levels

In the business management literature strategies are usually classified into four levels (see for example Hofer/Schendel (1978), Kotha/Orne (1989)). These levels are derived from the business management levels of industry (industrial policy), company (corporate strategy), business unit (competitive strategy) and functional department (functional strategy). The industry includes associations and governments as well as companies. Any strategy decision made on this level is considered as industrial policy. Typical topics discussed on this level are financial policy, import and export rules and conditions and labour regulations. Below the industry level is the company level, here strategies define the general orientation of the company such as the target market segments, company organization and integration of the strategic business units. Borwicz and Scherm (1999) discuss external standardisation strategies on this level. On the level of the individual business units a competitive strategy directly addresses the market of specific products. Here decisions concerning the scope of the business unit and internal orientation are made. The chosen competitive strategy has to ensure the long-term success of the business unit in the specific market segment. The functional departments try to realise the chosen competitive strategy of the business unit by creating and promoting successful products. Individual functional strategies are derived from the competitive strategy for each unit in the value-chain (e.g. procurement, production, marketing and distribution). Successful products following the desired competitive strategy are the key to the long-term success of the company.

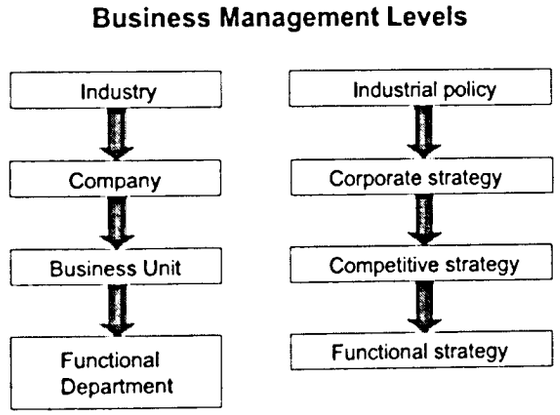


Figure: Business Management Levels (© EU-Asia Link HSU Hamburg)

2.2 Systematising the concept of strategy on the company level

As described in the previous section different types of strategies can be found for each business management level. In this section six commonly used definitions of strategy on the company level are presented to show the complexity of the subject. Then it is shown how they relate to the concept of in-company standardisation as a management instrument.

1 Strategy as a self-contained, standardized and integrated design pattern for decisions
This approach defines corporate strategy in a fairly general way as a basis for the universal and integrated design of the whole organization (cf. Hax/Majluf (1991)). The strategy ensures that the company is organized in a way that any managerial decision can be implemented. In addition strategic decision patterns are activated if discontinuities appear within the company. These discontinuities may be caused by fluctuation of management capacity or by external influences. In this case strategy may also be described as a pattern of directives on how to react to these discontinuities.

2 Strategy as a market sector selection instrument
Here strategy not only determines the selection of markets or sectors relevant to the company, but may also set the target growth within a sector/market and reply to questions of diversification or concentration within the competitive markets. The crucial strategic question for the management is: 'Which sector are we in?' and 'Which sector do we want to be in?'
Empirical surveys by an expert group have shown that this ostensibly trivial question cannot be answered unambiguously (cf. Hax/Majluf (1991) p. 3).

3 Strategy as an instrument to assign management tasks to different hierarchy levels
The decision makers in the hierarchical levels of the company organisation have different ways of influencing the design of a competitive strategy. Senior management has most of the relevant information required for making decisions on competitive strategy. Consequently, the tasks resulting from this for senior management are to be found in decisions on proposals that originate from lower hierarchy levels, such as business units or functional areas. Furthermore, senior management has to identify and exploit possible synergistic effects between different but related business units and allocate all kinds of resources in the best possible way. The management of the business units is responsible for the design of their divisions with the existing resources. The responsible management in the functional areas is in charge of designing the departments involved in the value-added process.

4 Strategy as an instrument to design the organisational structure, taking account of long-term objectives, action programmes and available resources
This definition is the classical interpretation of the term strategy (Chandler (1962) is one of the most prominent proponents). In this approach, strategy is taken as an instrument for planning the long-term objectives of a company, for determining action programmes and allocating the necessary resources. This pragmatic approach corresponds to the 'structure follows strategy thesis'. The term strategy in this thesis also includes the successive internal implementation of a competitive strategy. The implementation process includes formulation of company objectives, the implementation of necessary arrangements in the functional areas and the allocation of existing resources.
In this context the demand for a consistent strategy is stressed, because otherwise the combination of objectives and functional strategies on the one hand, and the allocation of human, financial, technical and physical resources, on the other hand, is not possible.

5 Strategy as a way to achieve a competitive advantage by assessing external chances and risks as well as internal strengths and weaknesses
This definition based on Michael E. Porter (Porter (1980)) describes strategy as a response to external competitive forces and internal strengths and weaknesses to ensure long-term company success compared to other competitors from the same sector. This procedure to analyse the competitive forces is aimed at determining the best strategy for a company or business unit.

Competitive forces in Porter's strategy model

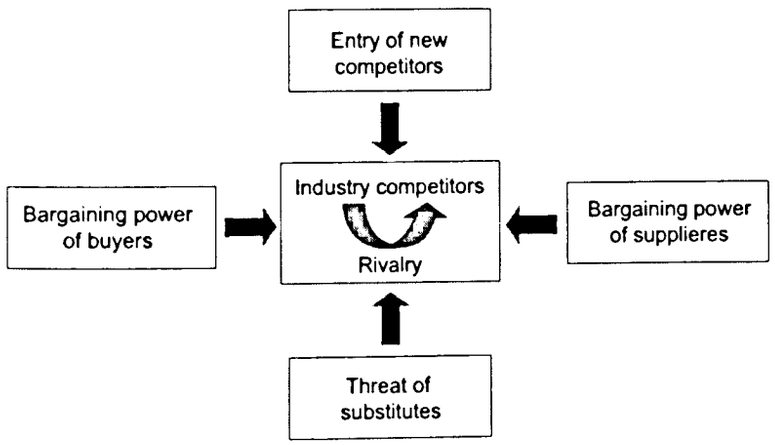


Figure: Competitive forces (© EU Asia Link HSU Hamburg)

Porter emphasises that a competitive advantage is influenced by external and internal factors.
Internally, the aim is to increase strengths and if necessary straighten out weaknesses. Strategy is not seen as a passive instrument in terms of a response to external changes. Instead, a strategy is used to influence the external competitive forces.

6 Strategy as a criterion for the intended economic and non-economic contributions of a company to its stakeholders
The relationship of a company to its stakeholders is another approach in the strategy-defining process. In this context the term represents all the persons or groups that are directly or indirectly influenced by the company's activities. This may include shareholders, managers, employees, customers, suppliers, creditors and associations of local authorities, but also residents.
By taking stakeholders into account in the process of formulating and implementing a competitive strategy, a much greater target group is included than if attention were merely focused on the group of shareholders or owners as it is usually done. As a result, the long-term aspect of the term 'strategic' is addressed more adequately than if the company objectives merely concentrated on the demands of the shareholder - maximising dividends and share prices.
Truly achieving a reasonable profit is the primary objective of any company, but focusing on short-term profits creates the risk of jeopardising the competitive position in the long run. A balanced consideration of all stakeholders reduces this hazard. External competitive forces such as customer satisfaction are also included in the 'stakeholder approach'.

Evaluation of the corporate strategy approaches
The underlying idea behind all approaches of defining the term 'corporate strategy' is the definition of the 'Organisation <–> Environment' interface. In this teaching module the idea of in-company standardisation as a strategic instrument is based on this approach as particularly expressed in definitions (3) and (4). These definitions define that the competitive strategy is implemented by functional strategies on the departmental level within the context of the 'structure follows strategy' thesis. Whether the internal implementation process is accomplished by a 'bottom-up' (3) or 'top-down' (4) approach is not of concern here, since this only addresses the concept of how decisions are made and does not affect the competitive and functional strategies themselves.
The scope of validity for competitive and functional strategies, however, is still subject to discussion in the economics literature. In this teaching module the competitive strategy is assumed to be of generic character which means its basic patterns are the same for all types of businesses and industry sectors.

2.3 Typologies of competitive strategies

In this section two typologies of competitive strategies are discussed as a basis for the strategic evaluation of in-company standardisation later in this module.

2.3.1 Competitive strategies according to Porter

Porter's typology of competitive strategies covers three generic competitive strategies. These strategies are called cost leadership, differentiation and focus. All strategies are intended to give the company a competitive advantage. However, there are also risks to all of these strategies which are also presented below.

Cost leadership
A company structures its value-added process in such a way that the production process is permanently cheaper than the processes of the competitors. The product demand in these markets is usually elastic.
Possible risks of this strategy are:
- Current investments and existing know-how can depreciate very quickly due to technological progress,
- New competitors can easily reach the same level of productivity by imitation of processes and investment in modern production facilities,
- Inability to recognize necessary shifts in products or the market because the attention is concentrated solely on costs,
- Unexpected increases in costs can quickly diminish the necessary difference to the competitor's prices in order to compensate for any existing differentiation advantage.

Differentiation
In this strategy the company tries to distinguish its own products from those of its competitors by exceptional performance, image or design attributes. The producers of differentiated products assume that their customers have a relatively inelastic buying pattern which makes higher pricing possible.
Possible risks of this strategy are:
- The cost differences between the differentiated products and cheaper products of a competitor are so high that the special features and performance advantages can not compensate for the cost disadvantage. This threat is typical for western high-tech products (cars, motorcycles, machine-tools) which are consistently under pressure from Asian competitors, for example
- The demand for the differentiated feature drops. This may happen if customer preferences change.
- Companies whose differentiation advantage is based to a large extent on a renowned brand name may lose their market share due to plagiarism.

Focus

In this strategy the company is restricted to those business units in which it is especially competitive and has its highest profit margins. Focusing on special market segments or core competencies is generally accompanied by variety reduction in parts held by the company.
Possible risks of this strategy are:

- There may be a decreasing difference between the products and services demanded by the target customer group and the market,
- Competitors open a sub-market within the target group on which the company is focused.

Porter first introduced these three competitive strategies in his book entitled 'Competitive Strategy' (Porter (1980)). In that edition all three strategy types were regarded as absolutely independent (singular), i.e. as non-combinable. The figure below shows this singular structure.

Singular competitive strategies according to Porter

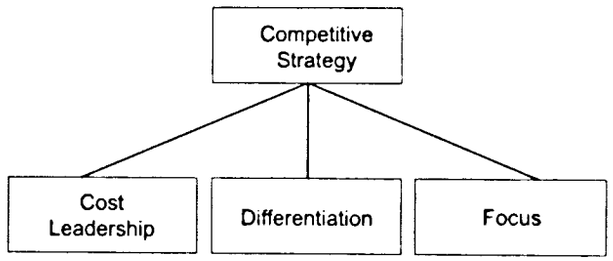


Figure: Porter's singular competitive strategies (© EU Asia Link HSU Hamburg)

In Porter's new approach the focus is no longer on an independent strategy. Instead, the fact that a company can survive against the competition only if it achieves a cost or differentiation advantage is stressed. The idea of focusing on a narrow market segment to increase profits is used in his current typology merely as a criterion to define the boundaries of the target market segment. The market share is used to decide whether to pursue a more focused (differentiation focus, cost focus) or broader (differentiation, overall cost leadership) market approach. Porter continues to reject the possibility of generating hybrid strategies through a combination of differentiation and cost leadership. To justify his typology Porter gives three hypotheses.

Convexity hypothesis

The strategy of cost leadership is usually linked to a high market share as economies of scale can be achieved in the manufacturing process of standardised mass products. One example of economies of scale is the learning process during production. The growth in experience allows a decrease in the unit cost of 20 - 30% once the cumulative production is doubled. However, a differentiation strategy is often associated with small market shares because Porter assumes that exclusive brand names are not compatible with high market shares (cf. Porter (1988) p. 66).
The figure below illustrates Porter's first hypothesis. In this model only a singular strategy can generate a high ROI. The convex shape of the graph is the origin of the term 'convexity hypothesis'. In Porter's typology it is implied that differentiation and cost leadership are not possible with the same market share.

Convexity hypothesis

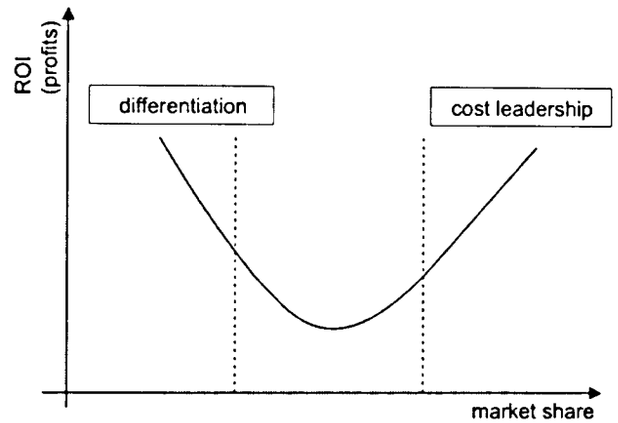


Figure: Convexity hypothesis (© EU Asia Link HSU Hamburg)

Porter's convexity hypothesis has been questioned by several publications. Studies have shown that a significant learning curve does not exist in all kinds of processes, especially in established processes which are typical for mechanical engineering (cf. Hill (1988) p. 407). In addition, some authors claim that there is only a significant effect in the initial phase of a process and no further reduction of costs is possible (cf. Alchain (1963), Baloff (1966) or Hall/Howell (1985)). Other studies show that the minimum-cost-effective size for a given industrial sector can be as low as 0.2 % market share (Scherer at al. (1975)) which also proves Porter's convexity hypothesis wrong or at least undermines its universal validity.

Concentration Hypothesis
Porter (Porter (1985)) introduces the so-called principle of concentration as a further argument for the singularity of competitive strategies. The principle of concentration states that a company has to concentrate its resources, structures and especially its functional strategies on one of the competitive advantage categories (differentiation or cost leadership) in order to reach a leading position. If a company violates this principle by implementing a hybrid strategy, it will meet competitors who, by virtue of their singular competitive strategies, have either a cost or a differentiation advantage. Therefore according to Porter it is not possible to create a profitable business.

Consistency Hypothesis
The combination of both differentiation and cost leadership in a hybrid competitive strategy makes it more difficult to determine and especially implement functional strategies because conflicts of objectives will occur more often. Porter describes this problem in his consistency hypothesis as a third argument for the incompatibility of differentiation and cost leadership.
In order to reach an universally valid typology, he postulates that

1. it should be always possible to clearly derive functional strategies from the competitive strategy,
2. all competitive strategies are clearly assignable to one of the four categories (collective exhaustiveness),
3. every competitive strategy can only belong to one category (mutual exclusion) and
4. any typology should be timeless.

The second postulate, in particular, is a weak spot in Porter's typology. Since numerous successful companies exist that pursue a hybrid strategy. One example is Volkswagen; its products offer luxurious and technically advanced features and a strong brand image comparable to BMW or Mercedes (supported by high-class products like the VW Touareg and the VW Phaeton) together with competitive pricing which is on the same level as Ford or General Motors (as in the VW Passat or VW Golf).

2.3.2 Competitive Strategies according to Wright

Wright, Pringle and Kroll (1992) have presented a different typology of competitive strategies to Porter. They advocate the existence of hybrid competitive strategies and underline their thesis with several company activities that support both cost leadership and differentiation aspects at the same time:

1. Focus on quality
A consistent, continuous improvement of product quality not only increases the quality but also reduces the cost of disposal, guarantee obligations and after-sales service.

2. Innovative processes
Innovative processes can often bring about cost-efficient production processes. In an ideal case the degree of differentiation can also be increased, for example by increasing flexibility and quality through a new flexible assembly system. Wright et al. (1992) give several examples in their work.

3. Innovative products
Product innovations can have a cost reduction effect, too. New products can for example be easier to manufacture and assemble without loosing any of their quality attributes.

4. System innovations
System innovations in the value-added chain are another instrument to support different competitive strategies. Through outsourcing some companies have managed to achieve a reduction in costs as well as an increase in product quality (cf. Gluck (1980)).

5. Multiplication of advantages through multiple skills
Highly differentiated companies may offer their design and development resources to other companies to reduce fixed costs and reduce their manufacturing costs through outsourcing of the production.
Wright et al. believe that a hybrid competitive strategy combining cost leadership and differentiation can be a successful strategy. Their typology has the advantage of taking into account a broader spectrum of competitive strategies. However it becomes more difficult to apply such a hybrid strategy to questions on the functional level of a company.

2.3.3 Competitive strategy as the basis for the evaluation of in-company standardisation

The evaluation of in-company processes has to rely on a typology of competitive strategies. Even though Porter's typology is not entirely convincing, it is a good starting point for the generation of functional strategies in relation to in-company standardisation. Deriving functional strategies from a hybrid competitive strategy can turn out to be extremely difficult. Nevertheless Porter's typology can also be transferred to companies with hybrid strategies by mixing generic functional strategies. Just like mixing colours it is possible to combine generic functional strategies to give a new hybrid strategy. How this

is done depends on the individual preferences of the management and cannot be discussed here.

2.4 Analysis of functional strategies in companies

Starting from Porter's typology of competitive strategies it is directly possible to derive functional strategies on the departmental level. The functional strategies are analyzed for the departments of design and development, procurement and production. Later in-company standards can be evaluated with respect to these functional strategies.

2.4.1 Tasks of functional strategies

Typically functional strategies fulfil three main tasks (Pümpin (1980)):

Detailing function
Functional strategies transfer the guidelines of competitive strategies to the functional department of a company. A specific functional framework for the operational management is created as a result of the practical interpretation of the competitive strategy.

Coordinating function
Functional strategies fulfil an important coordination task in companies. This is true for both vertical direction (concerning production factors) and horizontal direction (concerning processes). Functional strategies design the value-added process so that it fits the chosen competitive strategy in the best possible way.

Planning function
Functional strategies form the interfaces between the competitive strategy and its operative implementation in the different divisions. They define directives that provide the framework for the design of the functional divisions by the responsible management. Against this background, the functional strategies are used for determining the operative planning.

2.4.2 Functional strategies in design and development

The process of globalization, increasing competition in nearly every market sector, technical progress and other factors force companies to constantly develop new products or redesign existing ones with shorter product cycles for each new model. As a result, strategic orientation in the field of design and

development is becoming more important. Therefore the creation of explicit functional strategies is becoming a primary objective for companies to consolidate and enhance their own competitive position (cf. Quinn (1990) p. 147 and Erickson/Maggee (1990) p. 74ff.).
However, some authors (Brockhoff (1988) p.90ff) believe that the strategic orientation of the design and development department through the implementation of functional strategies is not possible because

- the innovative character in the development department is less open to standardisation,
- creativity is restricted,
- it is not always possible to give clear statements on the current planning and the applied techniques because of the strong dynamic nature,
- there is a lack of objectives in this functional division.

These objections offer no substantial reasons for not applying functional strategies to the design and development process. On the contrary, there are good reasons which support the strategy-approach:

- The various functional divisions require horizontal coordination to create an optimal value-chain of processes,
- Systematic planning reduces the risk of missing technology changes and late market entry,
- High costs of the research process require an efficient organization to support the competitive strategy successfully.

In the development process the know-how of the company is used to design new products or modify existing ones. From this point of view the following functional strategies are established.

Functional strategies for cost leadership in the field of design and development are:

- Development of products that allow high economies of scale in manufacturing and procurement,
- Development of processes for cost reduction in manufacturing and distribution.

Functional strategies for differentiation in design and development are:

- Gaining advantages through differentiation by means of innovative products,
- Development and construction of products that ensure fast and flexible manufacturing,
- Development of ecologically friendly products and processes,
- Shortening of product life cycles to allow faster adaptation to shifting customer needs,
- Research in the field of advanced technology to serve markets with high expansion rates.

2.4.3 Functional strategies in the procurement process

The shortening of innovation cycles accompanied by a reduction in the vertical production depth as companies tend to focus on their core competences has led to a rise in procurement quantities for many companies. In addition, the growing number of order items, which results from product differentiation measures, is increasing the strategic potential of procurement. Modern logistics approaches such as the delivery and allocation of the required raw materials together with just-in-time or just-in-sequence supply methods demand a high degree of quality and flexibility from both procurement and the supplier. In this context, a long-term planning approach for procurement using functional strategies is more than necessary. The importance of procurement for the business success is affected by internal (product and process specific) and external (buying market specific) factors. These are shown in the procurement matrix below, which defines the task of the procurement department:

Procurement Tasks In Different Companies
(from Kraljic (1998) p.42)

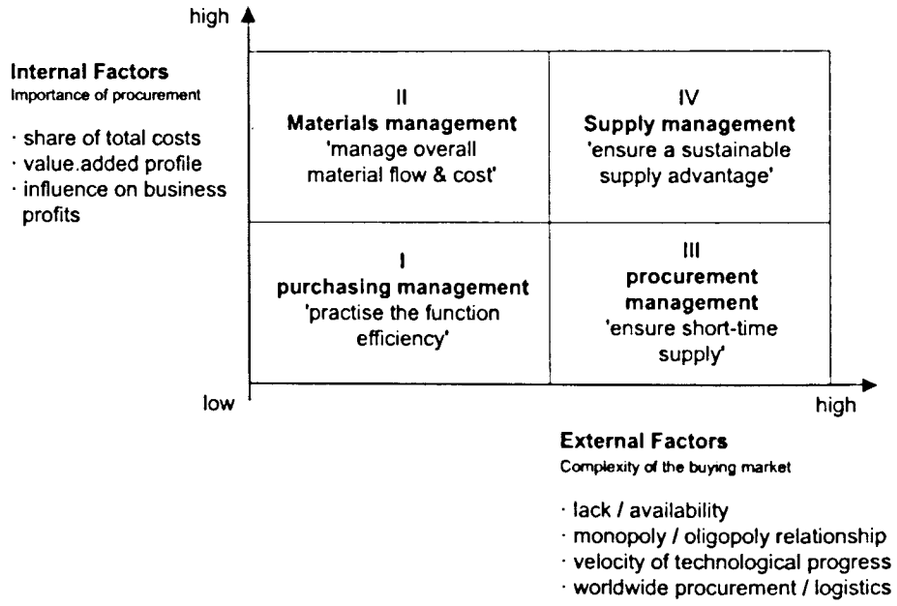


Figure: Procurement Matrix (© EU Asia Link HSU Hamburg)

The definition of internal and external procurement factors shows that a number of questions have to be answered when creating a procurement strategy (Reintjes (1995)):

- How can the procurement market position be protected?
- How can a maximum degree of flexibility be maintained?
- How can risks in procurement be spread more widely?
- How can the reliability of the supply-chain be improved?
- How can the target quality be guaranteed?
- How important is the company's own procurement autonomy?
- How important are partnerships with external institutions?
- How should the internal material flow be organised?

From the general questions concerning the tasks of the procurement department the following functional strategies can be described:

Functional strategies for cost leadership in the field of procurement are:

- Reduction of procurement and storage costs,
- Efficient handling of order transactions and
- Securing of material provision for the production process.

Functional strategies for differentiation in the field of procurement:

- Quality enhancement of raw materials and supplies,
- Higher flexibility in the field of procurement and
- Higher involvement of suppliers.

2.4.4 Functional strategies in the production process

Traditionally production planning has merely pursued tasks of operational planning and control within the production process. However, in recent years the production environment has changed so dramatically that this function also has to be organised on the basis of strategic guidelines. The reasons for this include the increasing incalculability of trends in demand, which calls for high flexibility in the production process, the constant increase in variety of model versions found in some industries and increased demands imposed on quality and delivery time. The functional strategies are primarily targeted at optimising three fields of activity within the production (cf. for example Zäpfel (1989)):

Production programme
The production programme determines the products, their characteristics and the batch size. In addition, the production programme manages the date of production and the allocation of required production capacities. In the long-term, production programme planning involves making strategic decisions on production depth and the policy regarding in-house and external production.

Production structure
The production structure deals with questions regarding the used production technology, the necessary production capacities and the locations of available manufacturing facilities. Design and development activities in the field of production processes are also discussed when the production structure is determined.

Production process
The implementation of the production programme inside the given production structure is the main task of the strategic production process planning. Production process planning involves decisions on the type of production process to be employed.
Strategic guidelines can be applied to the three fields of production in order to achieve differentiation or cost advantages. This can be illustrated by the following functional strategies.

Functional strategies for cost leadership in the field of production are:
- Reduction of changeover activities,
- Shorter changeover times,
- Reduction of volume of stocks and
- Reduction of defective products.

Functional strategies for differentiation in the field of production are:
- Higher flexibility in the production process,
- Reduction of throughput time,
- Fabrication of high-quality products and
- Ecologically friendly production processes.

3 In-company standardisation as a strategic instrument

In the section above, the term 'strategy' has been defined with respect to competitive and functional strategies. This theory can be applied to in-company standardisation approaches. The following in-company standardisation approaches are discussed in this context:
- Numbering systems including
  - Class lists of subject characteristics
  - Feature lexicon
- Size range systems
- Unit assembly systems
- Modularisation
- Quality management systems
- Environmental management systems

The in-company standards above do not include standards in the field of information and communication technology. In this teaching module only standards with direct relevance to industrial processes are addressed.
As we have seen during the discussion of functional strategies, reducing external effects, reducing transaction costs and supporting economies of scale are not the only important aspects that have to be considered. Other aspects that influence customer preferences or help to optimise the value-chain can not be omitted. The effect of standardisation approaches on functional strategies in development and design, procurement and production departments is presented and then combined to yield an optimum standardisation mix which gives general suggestions on how to use standardisation to support competitive strategies.

Relation of prices for standard and drawing parts
(Data provided by EADS Airbus GmbH)

Type of component	Price of drawing part (in €)	Price of standard part (in €)	Ratio
Washer	8.20	0.07	**117.1**
Bolt	3.22	2.27	**1.4**
Set screw	26.05	0.57	**45.7**
Screw	21.70	9.12	**2.4**
Pivoting Bearing	301.02	19.28	**15.6**
Bushing	7.67	2.30	**3.3**

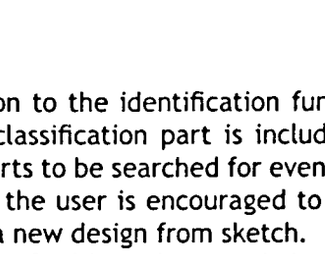
Figure: Cost Standard Parts (© EU Asia Link HSU Hamburg)

3.1 Numbering systems, class list of subjects and feature lexicons

Standardisation generally allows an overall reduction of parts used in a company and therefore makes significant cost savings possible. Additionally, standard parts are usually significantly cheaper than drawing parts.
Numbering systems, class list of subjects and feature lexicons are especially helpful in pursuing the cost advantage of standard parts. They allow easy access to information such as drawings, technical documentations or standards. Each piece of information is unambiguously identified by its own number. Once a working numbering system has been established, retrieval of existing information is simplified, supporting the use of repeat and standard parts.

In addition to the identification function of numbering systems, often an additional classification part is included in the number. The classification part allows parts to be searched for even if the part number is unknown to the user. This way the user is encouraged to use standard and repeat parts even when starting a new design from sketch.
Class lists of subject characteristics are another way of classifying items. They are usually used in connection with an appropriate numbering system. The description of an item is based on its main characteristics which are presented in a sketch of the object. Code letters are then assigned to the characteristics to clarify the sketch. By defining the value of each code letter the user can easily generate the right part number and gets access to all necessary design information. This fast and easy access to repeat and standard parts increases the likelihood that the designer will make of such parts and not design a new part.

Class list of subject characteristics
Here: metric screw according to DIN 4000 - 2 -1



Class List of subject characteristics DIN 4000 - 2 -1		
Subject Key		
Label	**Description**	**Unit**
A	Thread Ø	mm
B	Nominal Length	mm
C	Thread Length	mm
D	Wrench Size	mm
E	Head Ø	mm
F	Head Height	mm
G	Additional Attributes	
H	Material	
I	Surface or Coating	

Figure: Class List of Subjects Screw (© EU Asia Link HSU Hamburg)

Feature lexicons take the idea of class lists of subjects one step further. Here the classification system is extended to all products and processes on the basis of their features. Such a feature lexicon should also have an inter-company meaning, thus reducing transaction costs significantly. Unfortunately, as of this date, the only institution that has established any requirements for a future feature lexicon is the German Standards Institution (DIN).

3.1.1 Numbering/classification systems in development and design

Support of functional strategies for cost leadership
Numbering systems, class lists of subjects and feature lexicons strongly support the design of products that allow increased economies of scale in production and procurement. This is done by using of standard parts, finding repeat parts and reducing the number of new custom made parts. These effects are amplified if identical functions in different products or product versions appear. With fewer parts to handle, processes in production and distribution are also simplified and costs are reduced. The influence on this functional strategy is therefore also positive. In addition, an efficient numbering system is even more useful when a lot of data is being exchanged between divisions, suppliers and management.
The problem of increasing part numbers is well known throughout the literature. ISO (ISO 1982) determined a growth rate of parts of 5% per year. A study by Hesser & Hoops (2003) at a leading European supplier of systems for material handling has even shown a much higher rate of over 15%. Here the existing parts classification system had been neglected for several years which made it nearly unusable and further accelerated the increase in part numbers.

Case Study: Growth of material master data

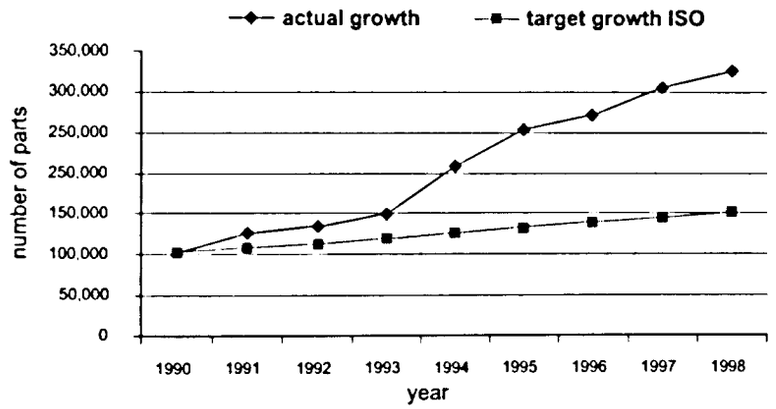


Figure: Growth in part numbers (© EU Asia Link HSU Hamburg)

Naturally the costs imposed on the company by this development were substantial. Only the part management produced additional costs of up to 50 million per year. This does not include the potential for economies of scale in production and procurement.

A detailed analysis of the effectiveness of variety-reducing standards has been performed by Meyer (1995) at the University of the Federal Armed Forces in Hamburg. Through a statistical evaluation of material master data and parts lists of several companies between 1982 and 1991, the studies performed by the ISO (ISO 1982) were extended and updated. The analysis proved the figures suggested by the ISO to be correct. Drawing parts showed an annual growth rate of between 4% and 7% whereas standard parts showed a level of 1% to 5%.
In addition to these results the correlation of overall number of parts, growth rate, application rate and standard parts ratio to the effectiveness of standardisation measures is discussed and presented in an empirical model. Further on the lifespan of standards and their effectiveness for variety reduction is presented.

Support of functional strategies for differentiation
Numbering systems and classification systems have a very similar effect on differentiation strategies. They can help to speed up the development of new products, through a simplified search for repeat and standard parts. This becomes very important when innovation loops are short and customer demands shift quickly.
However, the final products may not offer an optimal solution to the customer's problems and may not include the latest technology. On the other hand a potential for the differentiating advantage of high reliability exists through the use of standard and repeat parts, which are typically of proven design. The use of such parts also makes production more flexible and faster since NC (numerical controlled production machinery) programmes and work schedules already exist.

3.1.2 Numbering/classification systems in procurement

Support of functional strategies for cost leadership
As stated above, standardisation allows an overall reduction of parts used in a company and therefore makes significant cost savings possible. This is especially true for procurement and storage costs. Various literature sources estimate the costs for creation and maintenance of a single part as being in the range of as being to €2,500.
Numbering and classification systems all serve this goal of reducing the number of active parts. In addition to the obvious cost saving potential in procurement through economies of scale, this also reduces the overall procurement process complexity. Order processing is optimised, less storage space is needed and ,through multiple sourcing of standard parts, production downtime due to material shortage can be avoided.

Support of functional strategies for differentiation
There is only a moderate influence of numbering and classification systems on a differentiation strategy. Generally it is expected that higher product quality will be achieved through procurement of more standard and repeat parts. It is also possible to increase material supply flexibility through the use of such parts which will lead to shorter delivery times and greater flexibility in order handling. This can become an important differentiation aspect

3.1.3 Numbering/classification systems in production

Support of functional strategies for cost leadership
Numbering and classification systems have a very similar effect on a competitive strategy of cost leadership in production. Larger batch sizes due to a reduction of active parts reduce the amount of changeover activities. As the hanling of repeat or standard parts is usually familiar to the operator, changeover times are also greatly reduced. Both effects are amplified by the amount of standardisation within the various products. Standard parts are also significantly cheaper than custom parts, which reduces the value of any backup stock, thus freeing up capital. As repeat and standard parts are familiar to the employees and are usually technically proven parts, their usage can also reduce the reject rate substantially, allowing further cost savings.

Support of functional strategies for differentiation
As seen before, there is only a minor influence of numbering systems on any differentiation strategy. Generally it is expected that using standard and repeat parts will achieve a higher product quality because their handling is familiar to anybody involved in the production process. The flexibility of the production process might also be improved as it will be easier to handle a small number of standard parts than to organise a large variety of parts.

3.2 Size range systems

Size range systems are an important rationalisation method in development, design and production. Their major advantage is that design work is simplified as it only has to be performed once and different sizes of a machine can be derived from that basic design.
The underlying design principle in the development of a size range is the so-called 'similarity laws'. Similarity exists when the basic design and sequential designs have at least one physical feature where the relationship is constant, i.e. the proportions are invariable. The picture below shows a gearbox size range as an example:

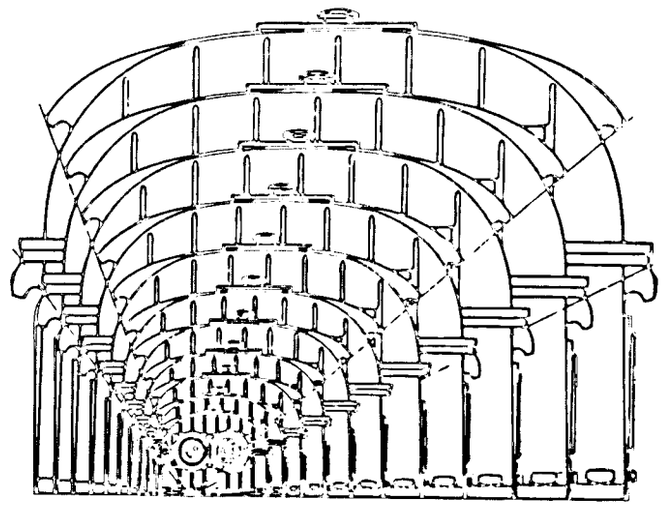


Figure: Display of a gearbox size range (Source: Pahl & Beitz, 1996 p. 418)

When a size range is introduced, it is necessary to determine, on the basis of customer preferences, market requirements and competitive strategy how many different sizes of the product will be offered and whether they should cover the whole market or not.
For more information on how size ranges are designed and used please refer to the module "Product development and design" (Chandana Perera - University of Moratuwa, Sri Lanka).

3.2.1 Size ranges systems in design and development

Support of functional strategies for cost leadership
Size range systems as another standardisation approach can be used to reduce costs in the design process, as described above. In this case calculation and design have only to be performed once, an effect that increases with a high number of product versions to be offered. Furthermore, size ranges may also have an effect on parts reduction. If a large number of overlapping product variants is reduced to a sparse size range, this reduces product and process complexity and the number of parts in use. Therefore in this context size range systems also support the development of products with high economies of scale in manufacturing and procurement. The higher the number of product variants before standardisation, the stronger the positive effects will be.

Support of functional strategies for differentiation
Size range systems have a fairly negative effect on any differentiation strategy because the same basic design is applied to all size steps of a product. This restricts technical innovation, prevents optimum solutions and makes the use of latest cutting-edge technology difficult. Shifting customer demands are also difficult to handle since the development of a size range takes more time than an individual design. If, however, one considers the whole size range line-up, development times can be shortened significantly since the basic design is also used for all derivatives. As the basic design is familiar and well-tested, size range products also tend to be very reliable and support the strategy of having a fast and flexible production as production steps are the same for all derivatives.

3.2.2 Size range systems in procurement

Support of functional strategies for cost leadership
Size range systems may also support the competitive strategy of cost leadership in procurement, but this again depends on how the company uses them. As described above, a size range system can be implemented only to reduce design work, in this way there will be no significant impact on procurement costs. If, however, the number of product versions is reduced by the size range system, significant cost reductions can be achieved, as shown before. The fewer versions of a product are offered the greater will be the effect of economies of scale and complexity reduction on procurement.

Support of functional strategies for differentiation
A size range offers no substantial differentiation advantage in the field of procurement. In some cases , though, it may be possible to increase the quality of materials through larger batch sizes and standardized manufacturing throughout the whole size range.

3.2.3 Size range systems in production

Support of functional strategies for cost leadership
The effect of size range systems on the costs level in production again depends highly on the number of variants produced.
A large step size between the variants reduces changeover activity and the size of backup stocks and therefore reduces costs. In any case, a size range system will reduce changeover times as employees are familiar with products and technologies. This will also help in reducing the reject rate.

Support of functional strategies for differentiation
Size range systems contribute to a differentiation strategy by various means. If a size range system reduces the number of product variant's the complexity reduction of all processes will allow more flexibility and larger batch sizes in production. This makes it easier to respond to shifting customer demands as throughput and response time are reduced. In addition, size range systems are based on a proven and technically sound basic design with detailed manufacturing and assembly plans. This generally reduces the production reject rate (which also affects costs) and stabilises the product quality.

3.3 Unit assembly systems

According to Hesser (1993), the unit assembly principle in production engineering implies that the products are decomposed into standardised building blocks or components that can be used to construct a certain number of products. In some cases the number of products may be even infinite.
The development of a unit assembly system makes sense if a variety of functions, possibly even in different sizes, can be implemented through a combination of several components or assembly groups. The intention is to keep the number of components or assembly groups as low as possible but still be able to assemble all the necessary variants which the customer demands. The final product created by combining the different building blocks can either be separable or inseparable, but the former is more typical.
The different building blocks of a unit assembly system are usually classified by the importance of their functions (cf. Pahl & Beitz (1997)). Another classification approach is whether they are mandatory or optional for the composition of the final product.
In any case, it is necessary to keep the customers needs at the focus of attention. After the introduction of a unit assembly system, some customers may experience performance losses critical to their application or simply will not be able to find a specific variant anymore. On the other hand new customers will be acquired as new variants will be offered and be easier to configure, and prices may become more competitive. Therefore a detailed analysis during the design process has to predict these shifts in the customer structure to make sure that the unit assembly system will be an economic success.

Composition of a unit assembly system
(cf. Pahl/Beitz (1997)

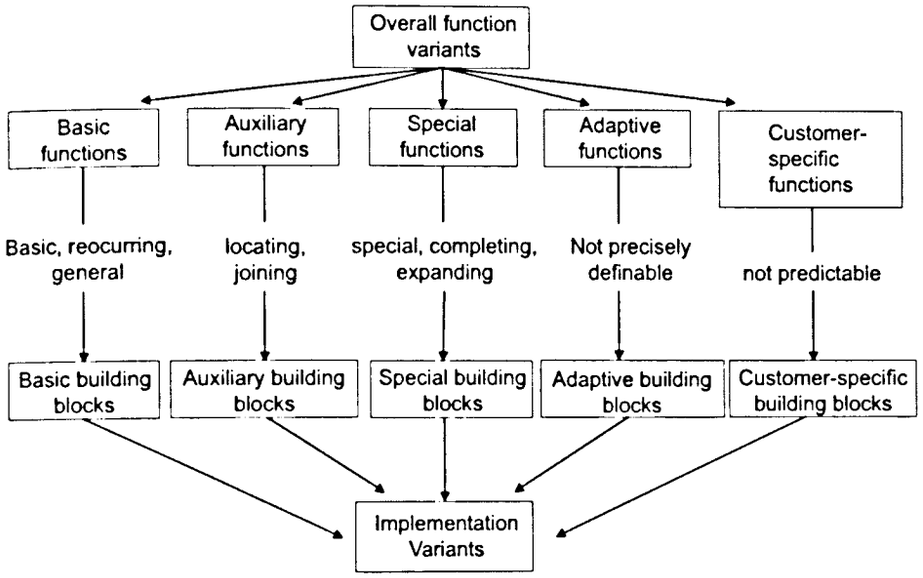


Figure: Unit assembly system (© EU Asia Link HSU Hamburg)

3.3.1 Unit assembly systems in design and development

Support of functional strategies for cost leadership
Unit assembly systems serve predominately as an instrument of parts reduction by dividing the technical product functions into a few standardised assembly groups which can be produced in large batch sizes. In this way they support economies of scale in manufacturing and procurement, not on the part level, but on the assembly group level. The more identical functions different product variants share, the stronger this effect becomes. Unit assembly systems also support the installation of cost effective processes in manufacturing and procurement. In particular, the assembly of a product at the very end of the production chain (late freezing-point) allows a complexity and cost reduction.

Tree of variants - Late freezing point
(cf. Eversheim (1996))

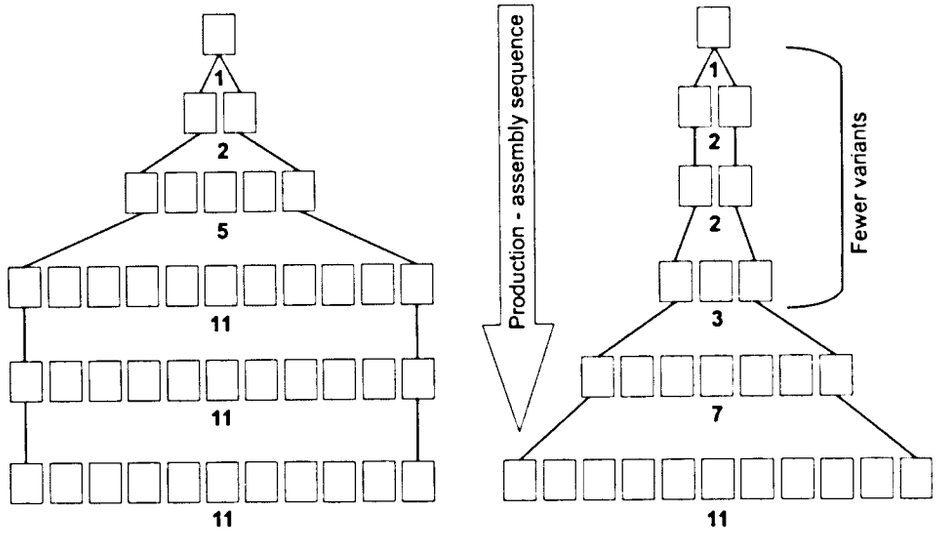


Figure: Variant tree (© EU Asia Link HSU Hamburg)

Support of functional strategies for differentiation
Unit assembly systems offer an innovative differentiation advantage because product adaptation to customers needs is simplified. This advantage is underlined if the product is designed in such a way that the consumer himself can adapt the product according to his needs. In the same way technical progress can be integrated very easily into the existing product, extending useful life of the product, which is an additional ecological advantage. Also the functional strategy of offering reliable products is supported because faulty components are in many cases easy to replace. This is usually required for expensive products where the customer demands a long lifespan.
Additionally, unit assembly systems can in many cases be produced in a very flexible manufacturing process. Large batch sizes for the individual parts can be combined with a final assembly at the very end of the value-added chain. This will shorten delivery times significantly.

3.3.2 Unit assembly systems in procurement

Support of functional strategies for cost leadership
Unit assembly systems serve in most cases also the reduction of active parts as described above. This allows costs savings in procurement and storage. Furthermore, the complexity reduction in procurement will allow a decrease in order transactions and simplify the material provision.

Support of functional strategies for differentiation
Unit assembly systems only exhibit minor potential for differentiation in procurement. Large numbers of the individual building blocks may increase material quality because suppliers can also be involved more easily. Complete building blocks may be procured from external suppliers. This, however, can hamper procurement flexibility as the number of potential suppliers is reduced.

3.3.3 Unit assembly systems in production

Support of functional strategies for cost leadership
Unit assembly systems obviously can support a cost leadership strategy. Larger batch sizes will reduce changeover activities, which also has a positive impact on the reject rate associated with each changeover. Additionally, if the unit assembly system has been designed efficiently, the building blocks are used in a variety of different products. Therefore the demand for each building block is usually quite stable and predictable, which allows a reduction in cost-intensive backup stocks.

Support of functional strategies for differentiation
Typically the throughput time can be greatly reduced by the introduction of a unit assembly system because automated production becomes feasible with large batch sizes and a continuous demand for parts. The late freezing point of the final product at the end of the assembly chain increases overall flexibility. If the customer demands short delivery times, the value of these aspects should not be underrated. Beyond that, automated production and simplified maintenance of unit assembly systems will increase product quality as a secondary effect.

3.4 Modularisation

At first sight modularisation seems to be a similar approach to standardisation as as that employed by unit assembly systems, but in fact the goal is completely different. Unit assembly systems are implemented to reduce the number of different parts necessary to offer a product range. Modularisation on the other hand is being used as a means of system complexity reduction. Therefore the modules are always separable and have well-defined interfaces with as few external relations as possible.
The figure below gives an example of how modularization reduces system complexity. Conventional car tail lights require a number of connecting lines from the tail light to various switches throughout the car, as the lights are all individual building blocks. In a modular design this is simplified. The complex inner design of the tail light with its control computer reduces the external complexity as only one power line and one control line have to be connected. Using this method on all car systems minimises the need for expensive wiring work and reduces assembly and maintenance work.

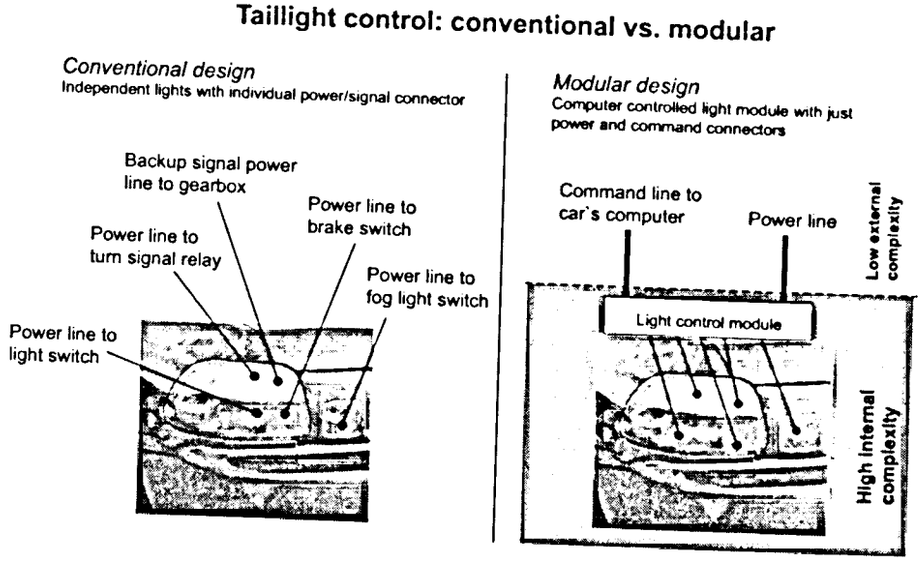


Figure: Modular Tail light (© EU Asia Link HSU Hamburg)

Modularisation can be implemented on different system levels, from the part level to the level of complex assembly groups. Higher levels of modularisation allow innovative engineering approaches such as simultaneous engineering and a reduction of the manufacturing depth because modules can easily be developed and manufactured by an external supplier. This only requires a well-defined external interface that is respected by everyone involved in the project.
For more information on how modularised products are designed and used please refer to the module 'Product development and design' (Chandana Perera - University of Moratuwa, Sri Lanka).

3.4.1 Modularisation in design and development

Support of functional strategies for cost leadership
Although the reduction of system complexity is the primary goal of modularisation, in most cases an overall reduction of active parts is still feasible as a secondary effect. In this way economies of scale are supported.
A direct advantage in design and development is the implementation of simultaneous engineering, which prevents cost-intensive interference between different engineering teams working on the same project.
In addition, modularisation makes new innovative processes in production and procurement possible that also hold a significant cost-saving potential. In production the final product can be assembled with only a minimum of technical skills, reducing the need for highly trained and expensive personnel. It also allows complete outsourcing of complex modules to system suppliers, sometimes including outsourcing of the engineering and design work. Such specialised suppliers are usually capable of offering these modules at a very competitive price.

Support of functional strategies for differentiation
Modularisation offers the innovative differentiation advantage of simplified adaptation of the product to customer's needs. Modularised products may in many cases even be modified by the customer himself. In the same way technical progress can be integrated very easily in the existing product, thus extending the useful life, which is also an additional ecological advantage. Also the functional strategy of offering reliable products is supported as faulty components are in most cases easy to replace. This is usually required for expensive products where the customer demands a long lifespan.
As described above, modularised products can be designed in parallel by 'simultaneous engineering'. This way the products can be adapted very quickly to shifting customer preferences. The shortening of innovation cycles may also support the progress of advanced technology. However, when considering the complete product, it may be difficult to achieve a technological break-through as many constraints imposed by the other modules have to be considered. In this case a completely new set of modules would have to be designed.

Modularised products can be produced in a very flexible manufacturing process as the individual modules can be prefabricated and considered 'off-the-shelf' parts. This way of combining large batch sizes for the individual parts with a simple final assembly at the very end of the production chain can shorten delivery times significantly.

3.4.2 Modularisation in procurement

Support of functional strategies for cost leadership
In many cases, modularisation also fulfils the aim of reducing the number of active parts. This allows costs savings in procurement and storage. The resulting complexity reduction will also allow a decrease in order transactions and simplify material provision.
Furthermore, as complexity is also reduced at the system level, it is possible to create a new type of procurement process. Special suppliers can deliver completely assembled modules directly to the assembly line. This allows optimisation of the procurement process and reduces costs significantly. In combination with just-in-time delivery, this can cut back storage costs to a minimum level.
However, this single-sourcing approach is a threat to reliable material provision. It requires constant monitoring of the suppliers, as problems in their value-chain can directly affect the company's production process with virtually no buffer-time.

Support of functional strategies for differentiation
The downside of the cost-saving potential of single sourcing is its negative influence on procurement flexibility. Usually just one supplier is capable of manufacturing a specialised module. Searching for a new supplier will possibly take a long time and requires long-term contracts.
On the other hand single-sourcing may very probably increase the quality of supplies and materials as the supplier has in-depth knowledge about the modules. In most cases the end-producer will probably be an important key account for the supplier, which gives its management a strong bargaining position to influence the suppliers processes. This can be used to either influence quality or other product attributes to the customer's and company's needs.

3.5.3 Modularisation in production

Support of functional strategies for cost leadership
As in many cases, modularisation will allow larger batch sizes so that changeover activities can be reduced, which also has a positive effect on the reject rate associated with each changeover. In addition, as the components are used in a variety of products the demand for each component is usually quite stable, which allows a reduction in cost-intensive backup stocks.

Moreover, modularisation makes error handling even easier as rejected modules are very easy to identify and replace. This will enable the production to save costs especially when the final product is of high value.

Support of functional strategies for differentiation
Typically the throughput time can be greatly reduced with the conversion to a modular design because automated production becomes feasible with large batch sizes and a continuous demand for parts. The late freezing point of the final product at the end of the assembly chain directly increases the overall flexibility. A high demand for short delivery times increases the differentiation advantage of both of these measures. Beyond that, automated production and simplified maintenance of unit assembly systems can increase the product quality.
In addition to positive effects on the the end-producer's production division, it is also possible to outsource individual modules to systems manufacturers. This may further increase throughput times and production flexibility. However, this concept can only work if the supplier is willing and able to accept interventions in its production process, which is usually true if the end-producer is one of its major key accounts.

3.5 Quality management systems

Quality management systems evaluate recurring activities in all of the company's divisions. Their objective is to optimise all recurring processes with respect to performance and efficiency and also make sure that the company is able to deliver the desired product quality by reproducing these recurring processes. QM systems do not address the product or its quality, therefore the producer of low-cost products can very well be certified by a QM system and facilitate high-quality processes.
Kleinemeyer (1997) characterises QM systems as transaction cost reducing standards. This refers to the fact that a QM system ensures that the product is of constant quality and the processes are constantly monitored. This makes it easier to choose a product or supplier as there is no longer any need to perform an individual evaluation of all processes.
One wide spread example of a QM system is the DIN EN ISO 9000 to 9004 system. For more details about this QM system see the module 'Development of the ISO 9001 Standards' (Prof. Dr. Mingshun Song and Dr. Jiang Dong Po - China JiLiang University of Hangzhou, China).

3.5.1 Quality management systems in design & development

Support of functional strategies for cost leadership
The concept of QM does not offer any direct support for any economies of scale. The effect on this functional strategy might even be negative since quality requirements might lead to shorter innovation cycles which has a negative influence on batch sizes. There is also no apparent focus on redesigning internal processes with respect to costs. Process quality is also more at the focus of attention here. However, as a secondary effect whenever processes are redesigned there is always a potential for optimisation. This mainly affects the administrative work share by simplifying processes and covering up redundancies.

Support of functional strategies for differentiation
Quality management systems suggest to the customer that he is buying a product of high quality. Although this is not necessarily the case, it represents a direct differentiation advantage. Additionally, as stated above, process redesign often opens up a new point of view on the whole development process. This might to a lesser degree encourage the design of innovative products and also might boost advanced technologies.

3.5.2 Quality management systems in procurement

Support of functional strategies for cost leadership
The effect of quality management systems on cost reduction in the procurement process cannot be clearly assessed. As a bottom line it can be stated that quality management systems incorporate cost reduction only as a secondary and indirect objective. It is even possible that the implementation of such a system might increase storage costs due to more ambitious warehousing standards.

Support of functional strategies for differentiation
Quality management systems strongly support increasing the quality of raw materials and supplies. However, quality requirements have a negative impact on procurement flexibility as they typically require that any supplier should also implement a similar system. This greatly reduces the number of potential suppliers as the QM system becomes a de-facto standard.

3.5.3 Quality management systems in production

Support of functional strategies for cost leadership
Quality management systems serve the goal of cost reduction in the production by analysing and evaluating all processes in the value-added chain. During

this auditing process, potential for the reduction of changeover activities may be discovered. In addition, a quality management system typically has a very positive effect on the reject rate, even though this may not an explicit aim of such a system. The latter point gains additional importance in the production of high cost products.

Support of functional strategies for differentiation
Quality management systems usually do not affect production throughput time and flexibility significantly - this may only happen as a secondary effect. However, they do ensure a constant product quality as this one of their core functions.

3.6 Environmental management systems

Environmental management systems are primarily used for the continuous improvement of a company's environmental protection standards. Kleinemeyer (1997) defines them as standards reducing external effects. Complex value chains, in particular, require an environmental management system to retain an overview of how the processes affect the environment. This is often achieved by creating an ecological balance sheet which
1. determines the flow of substances
2. classifies the type of impact
3. weights the environmental impact and
4. evaluates the options for improvement.

This is usually a very complex process which may lead to radical changes in production and in other processes. More details on the background and implementation of an environmental management system can be found in the module 'ISO 9000 and ISO 14000 Implementation' (Dr. Niranjan Gunawardena - University of Moratuwa, Sri Lanka).
Although the implementation of an environmental management system happens voluntarily in most cases, various economic reasons for the implementation exist. One reason is customer demand. Depending on the target customer group and the type of product customers are very likely to prefer, a product certified with an environmental management system has advantages over a product without such certification. Another reason is liability. Banks or insurance companies rate their customers by the likeliness of environmental damage that their processes and products might induce. Probably the most important reason is governmental regulation. Apart from legislation requiring the implementation of an environmental management system for certain industries, other sectors still have to obey state limits for pollution and other external effects. Keeping to these limits may not be feasible without the implementation of an environmental management

system. Furthermore, the new approach of controlling external effects through emission trading systems creates a market-regulated financial incentive for implementing an environmental management system (cf. for example the EU - ETS Emission Trading Scheme).
Moreover, exemptions in reporting obligations for certified companies (cf. Hesser (1997) p. 8) should only be mentioned as a minor aspect of legislative influence.

3.6.1 Environmental management systems in design and development

Support of functional strategies for cost leadership
Environment management systems force design engineers to constantly evaluate the sustainability of their products. This leads to shorter innovation cycles, which has a negative influence on the functional strategy of creating greater economies of scale. The focus on processes which cause least damage to the environment also makes it difficult to implement cost-effective processes in production and procurement because this latter aspect is always a secondary objective. Gaining a cost advantage through an environmental management system therefore requires special boundary conditions. This can involve refinancing through recycling of high-value materials, substantial reduction of energy consumption during production and product life cycle or financial advantages due to a governmental environment policy as described above. Other examples can be found in Hoops & Hesser (2003, p. 76ff).

Support of functional strategies for differentiation
Environment management systems are implemented to optimise all processes of the value chain with respect to environmental emissions. Therefore they directly support the strategy of designing ecological products and processes. This effect is amplified in the case of products involving serious ecological issues, such as producing waste and consuming large amounts of energy. Especially when these issues come to the attention of the public and therefore the customers, this can become a very critical differentiation point. An environmental management system will also in many cases support short innovation cycles because environmental considerations require a reappraisal of every product aspect. Although these are positive differentiation aspects, it has to be clear that negative effects on product reliability (hazardous materials with good technical attributes must be avoided) and the length of the development process has to be anticipated.

3.6.2 Environmental management systems in procurement

Support of functional strategies for cost leadership
Environmental management systems generally do not have a positive effect on procurement costs. Although there may be exceptions in highly specialised

companies that have to deal with exceptional environmental risks (cf. Hesser & Hoops (2003) p. 76ff), higher procurement costs are usually accepted for ecological reasons. Therefore the effect of environment management systems on the cost leadership strategy in procurement is assumed to be negative.

Support of functional strategies for differentiation
Environmental management systems also have negative effects on functional strategies of differentiation within the procurement process. The quality of raw materials and supplies is increased only with respect to ecological aspects. Other criteria, such as expected useful life, stability and performance, become secondary objectives for an environmentally inspired procurement. In addition, procurement flexibility is also greatly reduced as only few suppliers will be able to offer environmentally friendly goods and are in many cases also be required to implement an environmental management system.

3.6.3 Environmental management systems in production

Support of functional strategies for cost leadership
Environmental management systems have no direct effect on cost savings in production. In some cases a reduction of the reject rate may be achieved because any rejected part can be considered as unnecessary pollution. This applies especially to products containing hazardous materials.

Support of functional strategies for differentiation
Environmental management systems typically do not have a positive effect on functional strategies for differentiation either. Ecological demands may hamper efforts to increase throughput times and flexibility in many ways. However, if the customer is ecologically aware, he might appreciate environmentally friendly production processes as positive product qualities. Depending on the market situation, this can become a great differentiation advantage which outranks all other differentiation efforts.

3.7 The optimum standardisation mix

The previous section have presented the effects of in-company standardisation on the competitive strategies of cost leadership and differentiation with respect to the different functional departments. The individual standardisation approaches show different strengths and weaknesses. The management has to decide whether standardisation fits its competitive strategy and how the characteristics specific to the company,product and market affect the use of in-company standards.

From this point of view there is no optimum concept of in-company standardisation that can be applied simply to any company.
However, there are some dominant clusters which apply to most applications. The figure below shows these clusters.
Cost leadership cluster 1 describes the strong cost-reducing effect of the use of standard and repeat parts in design & development and procurement. This potential should be within the focus of any management trying to cut costs immediately without completely restructuring its products and processes.
Cost leadership cluster 2 includes technical standardisation principles of unit assembly systems, modularisation and size range systems. These approaches usually serve the goal of reducing overall costs in all departments. However, the effect may not be as strong as by enforcing the use of repeat or standard parts as other aspects come into play. The introduction of these concepts therefore requires a great deal of process and market evaluation.
Environmental management systems on the other hand typically have only negative effects on the cost structure. Therefore they are presented as a special cluster which is considered a threat to a cost leadership strategy. Without government or customers demanding an environmental management system, its implementation is in many cases more a moral than an economical issue. If the competitive strategy is aimed at product differentiation, then the differentiation cluster should move to the centre of attention. Unit assembly systems and Modularisation are the dominant approaches to offer the customer an individual product combined with cost-effective mass production.

Optimum Standardization Mix

	Cost Leadership			Differentiation		
	D&D	Procurement	Production	D&D	Procurement	Production
Numbering systems	Cost Leadership Cluster 1					
Class list / feature lexicon						
Size range systems	Cost Leadership Cluster 2					
Unit assembly systems				Differentiation Cluster		
Modulansation						
Quality management systems						
Environmental mngt. systems	Possible threat to cost leadership					

Figure: Optimum standardisation (© EU Asia Link HSU Hamburg)

4 Concluding remarks

This teaching module has shown that singular competitive strategies facilitate the development of functional strategies. Although Porter's typology which excludes hybrid competitive strategies is not fully convincing, it can be used to analyse the effect of in-company standardisation on processes and functional strategies. Hybrid typologies can then be generated easily by mixing generic competitive strategies.
The fitting of functional strategies with different in-company standards, explicitly excluding standards in the field of information and communication technology which are not addressed in this module, has shown that the reduction of active parts is the main focus of most standardisation approaches. The in-company standards above do not include standards in the field of information and communications technology. In this teaching module only standards with direct relevance to industrial production are addressed.
This applies especially to numbering systems, class lists of subjects and feature lexicons. These approaches show great potential for cost reduction in nearly every company environment. Cost reductions are also possible by the use of size range systems, unit assembly systems and modularised products. However, here the specific product, company and market specific circumstances have to be evaluated before making a management decision. Regarding a differentiation strategy unit assembly systems and modularisation are very promising approaches to ensure business success. Throughout design & development, procurement and production numerous competitive advantages have been presented to show the potential of these approaches.
Future research will try to understand why, despite these clear results which have been underlined by numerous company case studies (cf. Hesser & Hoops 2003), many managers still underestimate the positive effects of standardisation. Cost reduction through complexity reduction in parts and processes, in particular, is still underrated.

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6 Glossary

Competitive strategy
The way a company acts within a specific market segment with respect to competitors and customers. Decisions on product performance, product range and pricing are included in a competitive strategy

Cost leadership
A competitive strategy aimed at offering products that stand out against the-competition through competitive pricing. Optimising all in-company processes to achieve low production and distribution costs may, however, result in unacceptable setbacks in product quality and performance.

Differentiation
A competitive strategy aimed at offering products that stand out against the competition through differentiating attributes in the fields of performance, image, design, ecological sustainability or price.

Focus
A competitive strategy that dictates the concentration of all resources on producing and developing products that have been especially successful in the past and are expected to show the highest profitability. Other business units that are less competitive should be closed or sold to competitors.

Functional strategy
Directives or decisions patterns aimed at organising the tasks in an functional department. Functional strategies have a detailing, coordinating and planning function. (cf. Pümpkin (1980) p. 50ff)

Instance
In business management theory an instance is used for offices that have directive power over other offices. (Cf. Schreyögg (1998), p. 132)

Just-in-sequence
A form of just-in-time production where the suppliers are located at the customer's production plant and manufacture the necessary components in the same sequence as they are needed in the production process. This way of organizing the production has, for example, been implemented in the Smart factory in Hambach, France.

Just-in-time
Delivering services or materials for a customer just at the moment the service or material is needed. It is a special logistics method which reduces storage costs and frees up capital (cf. Schneck (2005), p. 533).

Key account
Very important customer that accounts for a significant share of the overall order volume.

Multiple sourcing
Procuring the same part of different suppliers. This makes the production process independent from possible production or transport problems from a single supplier. In addition, it increases the bargaining power of the procurement department.

Outsourcing
The spinning-off of company functions, departments or complex value-added pro-cesses to external specialists. This strategy is based on the fact that external contractors can often offer services and supplies for a better price than in-house departments. In a recession, in particular, significant cost saving potential is possible since fixed costs of the outsourced functions no longer have to be covered anymore. (cf. Schneck (2005), p. 773)

Quality
ISO 9000 defines quality as the degree to which a set of inherent characteristics fulfils requirements. Another more detailed definition Is given by Schneck (2005): Performance of products and processes in companies. This includes substantial technical value and the subjective assessment of quality. Substantial technical attributes include reliability, interference, robustness, durability and lifespan. Apart from these objective quality attributes, subjective attributes include design, emotional and image factors.

ROI
Return on investment. Indicator of a company's profitability. It describes the relationship between the operating profit and the employed capital or net assets. (cf. Schneck (2005), p. 880)

Single sourcing
Procuring one part or module only from only one supplier. In the case of high volume producers, this usually gives the customer a great deal of control over the supplier. His production process and financial calculations may be under the constant evaluation by the customer. However, problems in the suppliers value-added chain directly influence the customer's processes with virtually no buffer time since there is usually no other supplier that can deliver the same service or component.

Standardisation mix
A combination of different in-company standards that suit the chosen competitive strategy and other factors specific to product, market and company.

Strategy
There is no universal definition of strategy. Often strategy is related to military aspects in the first place. Here strategy is defined as the way of using all available forces so that they are most effective and contribute to ending the war. In economics a number of strategy approaches exist. Usually they apply to competitive strategy, which also means using the company's resources in a way that ensures maximum profit.

Structure follows strategy thesis
This thesis invented by Chandler (1962) based on extensive case studies states that the company organisation should not be based on historic or management-decisions but should instead serve the only purpose of supporting the corporate and competitive strategies.

7 Key questions

- Why is Porter's approach to competitive strategies still so much at the focus of attention, despite its flaws?
- Does a universal definition of strategy exist?
- What does complexity reduction mean?
- In which department should a standardisation project start?
- Environment management systems are rated as a threat to cost leadership and also seem to bring few differentiation advantages. So, why would anyone introduce such a system?
- My company is trying to offer a highly differentiated product, so why would I want to pursue any in-company standardisation? My customer probably would not appreciate such a strategy?

Niranjan Gunawardena

Abstract

It is through innovation that companies gain a competitive advantage to become successful in business. With innovation comes standardization as a business strategy for achieving success in markets both local and international. External standardization is about developing and establishing external standards in markets. The external standardization strategies of a company include: positioning itself with respect to the development of a new standard; establishing a new standard; and competing successfully within an established standard.

This lecture addresses these issues in three stages. Chapter 2.1 discusses general issues in external standardization. Chapter 2.2 presents a detailed account of de-facto standardization process, whereas, Chapter 2.3 deals with strategic issues related to formal standardization. Concluding remarks are given in Chapter 3.

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1 Preface

A company achieves a competitive advantage through acts of innovation (Porter, 1990, p.74). Successful companies innovate new technologies and new ways of doing things. With innovation comes standardization as yet another business strategy for achieving success in both the local and international markets. In this context, external standards should be viewed as building blocks for a broader business goal: strategic standardization. However, many companies still do not take external standardization seriously. This is quite evident in the study carried out by the German Institute for Standardization (DIN, 2000, p.8) in three countries, according to which many companies are unaware of the strategic importance of standards. On the other hand, there has been a growing interest among companies in the recent past about the importance of Intellectual Property Rights (IPR) such as patents and copyrights. For example, hardly any company nowadays performs strategic planning without analysing its patents situation. As a strategic instrument, standards are at least just as important as patents. The same applies to standardization as a corporate strategy, because it can either open up new markets or screen off markets for a company (Daimler Chrysler, 1999, p.4). The outcome of the contest between VHS and Betamax for establishing a Video Cassette Recorder (VCR) standard is an example that illustrates the importance of the role played by external standardization in business.

This lecture presents its contents in three main stages. First, it identifies the aims of external standardization and then looks at the fundamental issues such as types of standards, benefits, positioning strategy, and IPR related to external standardization. Second, it describes how companies use various enabling strategies to create de-facto standards and establish them in the market. It also deals with continuation strategies adopted by companies once their standards are established in the market. Finally, the lecture presents strategies adopted by companies in formal standardization, which is the process used to create de-jure standards. All products have their own limited life cycles so the related standards will in fact keep on changing. However, the strategies applicable to external standardization continue to remain more or less unchanged. There is a plethora of literature available on the subject, mainly, in the form of research articles. Some of them were written more than 20 years ago and some discuss issues as old as railroad gauge standards, yet they all provide the readers with new insights and knowledge, and a better understanding in the subject area of standardization. Most of the graphical illustrations contained in the lecture were taken from the Internet. The sources of information and illustrations used for the lecture are given wherever possible mainly for copyright purposes, but the underlying intention is to enable the readers to follow the links. In doing so, it is expected that they will learn more details and find new sources to enhance their knowledge.

2 External standardization strategies

There are three main topics considered under external standardization strategies in this lecture: introduction to external standardization; de-facto standardization; and formal standardization.

2.1 Introduction to external standardization

The process of developing company standards is called internal standardization while that related to national, regional and international standards is called external standardization.

Company standards are usually technically driven rather than market-driven. These mainly include: variety reduction standards, which are useful in achieving economies of scale (Swann, 2000, p. 7) and better coordination among production units (Zaninotto, 1998, p. 91), and operational standards (De Vries, 1999, p. 170) such as quality standards. Company standards created through internal standardization are considered to be more effective in achieving lower production costs than external or industry-wide standards (DIN, 2000, p.13). External standardization, on the other hand, focuses mainly on business issues such as product acceptance and new market entry rather than issues related to efficiency and productivity at company level. Therefore the roles and functions of standards are becoming more business-oriented instead of being merely technical in nature. There are some important trends in the way companies treat standardization. Many companies are now shifting from company standards to national, regional and international standards (Betancourt and Walsh, 1995, p.120).

2.1.1 Aims and objectives of external standardization

The main aim of external standardization is to use standards as a competitive advantage. The related strategic objectives of a company are threefold: (a) to ensure that whichever standard it chooses is established in the market; (b) to maximize its individual returns from the standard; and (c) to be able to compete effectively in the market once the standard has been established (Grindley, 1995, p.20). However, it should be noted that to achieve all these, the standards need not always be technically superior. For instance, the widely used QWERTY keyboard is considered to be inferior to several other keyboard layouts that have not been able to achieve similar success in the market.

Establishing standards
This is the most important aspect of external standardization: unless a standard is established it is not possible to maximize profits or compete within the standard. Before establishing a standard, a company must adopt a suitable positioning strategy (see Section 2.1.4 for details). This allows the company to decide whether to develop its own standard or to adopt an existing standard developed by another company, then to decide whether the standard developed or adopted should be an open or proprietary standard (see Section 2.1.2 for details). If the company decides to develop and establish a new standard, it must next consider the necessary enabling strategies to be successful in its endeavour. The enabling strategies include (Chiesa et al., 2002, p.433): the form of corporation with other companies (see Section 2.1.6); tactics to win possible standards contests (see Section 2.2.4); and timing of standardization (see Section 2.2.5). MS-DOS and the VHS Video Cassette Recorder (VCR) provide excellent examples where enabling strategies have been successfully used.

Maximizing profits
A company should also consider profit maximization strategies for increasing its return from the standard it has established on its own or with the cooperation of other companies (Grindley, 1995, p.20). The basic question here is how to share the market with respect to the standard. The company would either resort to sharing a large market or dominating a small niche. The option would depend on the degree of proprietary control it retains over the standard in order to keep some edge over the competitors. As a result, the company would end up with either an open standard or a proprietary standard (see Section 2.1.2). Microsoft's proprietary control over its Windows operating system enabled the company to maximize profits. This subject is further discussed in Section 2.1.5.

Competing within established standards
Companies use strategies once a standard has been established in the market to compete effectively in business within the boundaries set by the standard. These strategies are known as continuation strategies (Grindley, 1995, p.48), which include: increasing proprietary control over its standard, increasing compatibility, technological development, creating complementary assets, developing new standard products and vertical integration (see section 2.2.6 for details). For instance, Japanese companies who won the VCR contest went on to produce Camcorders as a continuation strategy (developing a new standard product).

In fact, positioning, enabling, profit-making and continuation strategies are interdependent. Therefore, positioning strategy and enabling strategies should be made with profit-making and continuation strategies in mind. For example, if the company decides to change its positioning strategy from open to proprietary, there can be consequential effects on the other strategies as well.

When IBM changed its strategy of an open personal computer standard to a proprietary PS/2 standard in 1987, it was unable to hold on to its continuation strategies successfully.

2.1.2 Types of standards

Standards could be divided into three main classes (De Vries, 1999, p.171): basic standards, requiring standards, and measurement standards. Basic standards provide general descriptions and requiring standards define requirements for an entity or relations between entities. Measurement standards provide methods to be used in checking whether the criteria given in requiring standards are met. In this category, requiring standards include: compatibility standards, quality standards, and interference standards. Compatibility standards are used for fitting interrelated entities to one another to enable them to function together; quality standards define the requirements for entity properties to have minimum levels of quality; and interference standards set requirements regarding the influence of an entity on other entities such as safety, health and environmental requirements (De Vries, 1999, p.161-163). Further, the standards applicable to products can be divided into several categories in terms of (Grindley, 1995, p.21): the features or specifications of the product, for example, quality standards or compatibility standards; the process by which they are created, either de-facto standards or de-jure standards; or the type of access to the standard, open standards or proprietary standards. Of the first category, only compatibility standards are used by companies in external standardization; the other two categories are described in the following subsections.

De-facto and de-jure standards
De-facto standards emerge from market-mediated processes and hence are called market standards as well (Swann, 2000, p. 5). Successful de-facto standards become so widely adopted that they are generally used to guide product design. These standards are not subjected to public evaluation or concurrence and the parties developing them usually have limitations on participation (McDowell, 2004, p. 10). These standards are developed by individual companies or by industry trade associations or consortia. Those developed by trade associations are sometimes known as industrial standards or committee standards. De-facto standards are usually totally proprietary and unavailable for used without licensing fees and/or restrictive agreements. Microsoft Windows is an example of a de-facto standard.

De-jure standards include mandatory standards and voluntary standards (Chiesa et al., 2003, p.282). Mandatory standards are promulgated by governmental agencies with regulatory authority, and voluntary standards are developed by National Standards Bodies (NSB) and international or regional standards development organizations, which are broadly known as Formal Standardization

Organizations (FSOs) (David, 1995, p. 17). These emerge through political deliberations or administrative procedures (David, 1995, p.17). A key characteristic of these standards is that participation in the standard-setting process is open to all affected parties or stakeholders. The Standard Generalized Mark Up Language (SMGL) published by ISO is an example of a voluntary standard, whereas, national environmental standards developed by governmental authorities are mandatory standards.

Open and proprietary standards
Open standards are those considered to have diffused widely and been adopted by most companies in the market. The companies using them are not required to pay for the right to manufacture products in accordance with the standard, other than nominal fees (if any) imposed by the Formal Standardization Organization (FSOs). IBM's PC architecture and JVC's VHS format for Video Cassette Recorders (VCR) are examples of open standards. Proprietary standards are controlled by a single company or by a handful of companies. These standards are protected by Intellectual Property Rights (IPR). Other companies are required to pay for the rights to use these standards. Apple computer and Microsoft Windows are examples of proprietary standards.

2.1.3 Benefits of external standardization

External standardization, through compatibility standards, brings three types of benefits: (a) complementary product market, (b) portability, and (c) connectivity (Grindley, 1995, p.26).

Complementary product market
Compatibility standards create and enlarge the market for complementary products. Compatibility makes complementary products available in high quantities and greater variety, which in turn attracts more complementary product manufacturers and thereby reduces the price of such products. Further, high volumes of complements enable manufacturers to achieve economies of scale, which results in low costs of production. Other benefits include savings in education costs, and greater availability of people trained to use the standard and perform product maintenance.

Portability
Compatibility standards enable the movement of complementary products from one core product to another; this phenomenon is known as portability. Portability increases the value of the complementary products to the user. Further, it minimizes or eliminates the switching costs of conversion or retraining, and thereby protects the user 's investment. When the same standard is adopted by different manufacturers, users are less likely to be locked-in to a particular manufacturer and therefore, they can shop around for the best price.

Connectivity

Compatibility standards allow different core products to be connected together in networks. This increases the direct benefits of having more uses for core products and the ability to share components. For example, several IBM computers could be connected to an HP laser printer. It is also possible for the users to 'mix and match' low-priced products from different manufacturers: for instance, a Sony TV with a JVC video cassette recorder and a Sanyo CD player.

Other benefits

The benefits of external standardization go beyond compatibility standards; these include (Blind, 2002, p. 1985; DIN, 2000, p. 9 - 17):

- Due consideration for environmental and safety issues. This also reduces the risk of product liability for companies.
- Higher and more reliable products at a reasonable price for customers through quality standards.
- Maintenance and repair are easier with standardized products.
- Help in lowering trade barriers and enabling companies to compete in regional and global markets.
- Reduction of research and development (R & D) risks for companies through participation in standardization.

2.1.4 Positioning strategy

The positioning strategy is concerned with two decisions made by companies planning to develop or adopt standards. These decisions are related to: (a) leadership in standardization and (b) access to the standards (Grindley, 1995, p.29-30). With respect to the leadership, a company may decide either to develop its own standard (see Sections 2.1.6 and 2.2.2) or to get actively involved in the development of a standard through cooperation between several parties (see Sections 2.1.6 and 2.2.3). Access to the standard, on the other hand, is about whether to develop or adopt an open or proprietary standard (see Section 2.1.2 for details). Depending on a company's decisions regarding leadership and access, its position could be one of the following (Grindley, 1995, p.30):

- Leader/Proprietary: Develop and defend a proprietary standard (control its use by competitors)
- Leader/Open: Develop and 'Give away' or encourage competitors to use its standard
- Follower/Proprietary: Adopt or license-in a proprietary standard developed and controlled by a competitor
- Follower/Open: Adopt an open standard, which is also known as cloning.

Strategic Positioning Decisions

LEADERSHIP	ACCESS		
		Proprietary	**Open**
	Lead (Develop)	Sponsor/ Defend	'Give Away'
	Follow (Adopt)	License in	Clone

Figure: Strategic Positioning Decisions (Source: Grindley, 1998, p.30)

The leadership decision depends on the technical and financial capabilities of the company to develop and introduce a winning standard. It also depends on the strength of the standards being developed by competitors and their stage of development. The access decision would determine the power that the company could exert in the market through the standard. In fact, this is determined by the strength of the Intellectual Property Rights (IPR) that the company has over the technology specified in the standard (see Section 2.1.5 for details). A company must consider possible costs and benefits associated with the particular positioning strategy it is adopting. The costs and benefits for a given situation would depend on several factors such as the strength of IPR, technical leadership, speed of standardization, resources available, and the tactics the company would use to win a possible standards contest. A company's positioning strategy depends on its chances of winning or losing a possible standards contest and the corresponding payoffs. Choosing the option of leading or following could, therefore, be considered as a 'battle of sexes' game. Other games, well known in game theory, such as 'prisoner's dilemma', 'rather fight than switch' (Grindley, 1995, p.34) or 'Pesky Little Brother' (Besen and Farrel, 1994, p.126) can also be used to explain the decisions of companies to lead or follow in standardization.

Factors affecting strategic positioning

		ACCESS	
		Proprietary	**Open**
LEADERSHIP	**Lead** (Develop)	Strong property rights Technical leader Long time lead Strong differentiation Large resources	Weak appropiability Leading possibilities Speed essential Support needed Resource limited Propietary threat
	Follow (Adopt)	Established standard Technical follower Late entrant Niche possible Cost competitive	Dominant propietary standard Late entrant Product differentiation Small resources Cost competitive

Figure: Factors Affecting Strategic Positioning (Source: Grindley 1998, p.31)

2.1.5 Strategic use of intellectual property rights (IPR) in standards

Method of integrating IPR and standards

New technologies and products are often protected by IPR. The types of IPR usually associated with standards include patents and copyrights.

If a patented technology is incorporated into a standard without a patent-holder's agreement to share its patent rights with other users of the standard, legally the patent-holder becomes the only company able to comply with the standard, which is the case in some of the de-facto standards. However, too much proprietary control through IPR could make it difficult for a standard to achieve network externalities and other benefits of standardization.

If a company other than the IPR holder needs to use the technology covered by the patents in a standard, the former has to pay licence fees to the latter for the rights to use it. For example, licence fees must be paid directly to Microsoft for using the Windows computer operating systems in computers. Other forms of licensing, namely, cross-licensing and patent pools are discussed in the following subsections. Finally, the antitrust liability that may derive from the use of IPR to maximize profits through anticompetitive behaviour is discussed.

Cross-licensing

The cross-licensing method can be used when two companies have essential patents or blocking patents embedded in a standard (Shapiro, 2001, p.9). Instead of blocking each other and seeking legal action or ceasing production, the

companies can enter into a cross-licence agreement, where each company is free to use each other's patented technology in designing a product without fear of infringement and in pricing without additional cost per unit due to royalties paid to the other company. The agreement could be either royalty-free (RF) or a fixed amount paid at the outset. The cross-licence agreement between Intel and IBM is a good example of where patent portfolios of the two companies are licensed to each other. Often, cross-licences do not involve 'running royalties', although they may involve 'balancing payments' at the outset reflecting the differences in strengths of the IPR portfolios of the two companies. It is also common for companies to agree to grant licences to each other for patents that will be issued several years into the future during the lifetime of the cross-licensing agreement.

Patent pools and package licensing

Patent pools can be used to avoid complements problems occurring in situations where a company has to obtain IPR licences from several other companies holding patents essential for the use of a given standard. Under a patent pool or package licence, all the essential patents or blocking patents associated with a standard are licensed as one package, either by one of the patent-holders or by a separate organization created for this purpose (Shapiro, 2001, p.9). The package licence is issued to any party willing to pay predetermined royalties for the entire package; the proceeds from the sales are divided among the patent-holders proportionately. Such package licensing should not be used for substitute patents or rival patents as this would create a monopolistic situation. For users of the standard, obtaining a licence for the associated patent pool is a better option than having to obtain licences from all the individual patent holders. It offers the convenience of 'one-stop shopping' and avoids the potential danger of paying for some patent rights which may be useless without other essential patents. The MPEG-2 video compression technology is a good example of a patent pool, where patents from nine organizations are pooled and licensed as a package.

Antitrust liability

Antitrust liability can occur in the standard-setting process when the participants work to exclude competitors from the market. Antitrust liability is mainly present in the area of proprietary standards. A situation where the sponsor of one standard discouraging the licensees of its standard from using substitute technology could lead to an antitrust liability case. The first antitrust case against Microsoft provides an excellent example (Gifford, no date, p.5). Microsoft used to issue licences to computer manufacturers for installing a number of Windows systems equal to the estimated entire production capacity of the licensee. As a result, the licensees were discouraged from using alternative operating systems, since they had already paid for the buying rights to install Windows for all the computers they could produce. Therefore a manufacturer would not consider installing an alternative system such as IBM's OS2 (or any

other system available at the time) even for some of its computers as it would incur additional licence fees. The risk of antitrust in the exclusion of rivals from the market is less for open standards than for closed or proprietary standards; however, this can be problematic if the participants attempt to block others from complying with the standard or seek royalties from outsiders, particularly when the standard is mandatory. Similar legal implications may arise in the application of patent pools for standards. If the patents pooled are not complementary patents, but substitute patents, the situation could clearly be anti-competitive. When substitute patents are packaged together, it can eliminate competition from the market and lead to elevated license fees.

2.1.6 Forms of cooperation in external standardization

The forms of cooperation in standardization can be broadly divided into four categories: (a) stand-alone or unilateral; (b) developing consortia/alliances; (c) sponsoring consortia/alliances; and (d) standards development organizations (Chiesa et al., 2002, p.435).

Stand-alone (unilateral)
This situation occurs when an individual company decides to develop a compatibility standard on its own without the cooperation of any other company or companies. Strictly speaking, this is not any form of cooperation, but it represents the extreme case of non-cooperation in setting standards. In order to succeed, the company should have considerable amounts of resources and expertise. If it manages to establish its own standard, the company could exert significant power in the market. For example, by adopting a stand-alone approach, Microsoft has managed to dominate the PC Software market.

Developing consortia/alliances
Here, two or more companies get together to develop a new technology to propose as a standard. During the development of the technology, the firms share resources and expertise, thus reducing the costs and risks substantially. For this type, a high level of trust between partners is essential. The most important characteristic, however, is the high market power of the cooperation, which is related to the absolute size of the partners or their reputation in the market. This type of cooperation consists of two different stages: development of the technology and, establishment of the technology as a standard. For example, Sony and Philips pooled their resources to develop the Compact Disc (CD) standard.

Sponsoring consortia/alliances
Here, two or more companies get together to sponsor an existing technology as a standard. One characteristic of this type of cooperation is the high market power in terms of access to distribution channels, brand, production capacity,

etc. The success would depend on the degree of compatibility of the partners' technologies. This usually requires low rivalry between partners. If partners are close rivals, the probability of success in standardization is very low; in the case of distant rivals there is a better chance for success. MS DOS is a result of Microsoft and IBM together sponsoring an existing technology to make a standard.

Standard Development Organizations (SDO).
SDOs offer a particular form of cooperation. They are similar to sponsoring consortia, but with two important differences. First, they allow the involvement of all interested parties in the market and not only a fraction of them. Second, they are usually characterized by a lesser degree of cooperation between parties. Indeed, if companies or alliances are not able to set a standard by themselves, in order to do so, they may be compelled to participate in SDOs, even when they are competitors in the market. Hence, members of SDOs do not always whole-heartedly cooperate, because participating in an SDO could be only a matter of necessity and not a conscious choice. Therefore opportunistic behaviour of individual firms can be seen in the standardization process to gain private benefits rather than greater common benefits; this is clearly explained by the phenomenon called 'prisoner's dilemma'.

2.1.7 Time and compatibility in external standardization

A coalition or cooperation that includes all interested parties in the standardization process is called a grand coalition. It is the most centralized coalition among all types of coalition available for standardization. For example, in the case of a standard that affects an industry, this will be an industry-wide coalition. Therefore an industry consortium is close enough to be a grand coalition, and FSOs, by their very nature, fall into this category as well. A competing coalition or alliance, on the other hand, is a cooperation between a relatively small number of participants interested in setting a standard for a given technology. As there can be several of these alliances competing with each other, such a situation may lead to a more decentralized structure in external standardization. Industry consortia and FSOs are more likely to achieve high compatibility between technologies used in an industry than competing alliances. There is, however, a compromise in the speed of standardization. Competing alliances usually take less standardization time than grand coalitions. The time taken for developing a standard and the compatibility achieved in the standard depend on the form of cooperation. Usually, the time for standardization and compatibility both tend to increase with the increase in size of the coalition (van Wegberg, 2004, p.21). Therefore, the time taken for developing a standard through an FSO is expected to be longer than that for a market standard. Compatibility, on the other hand, is highest in the FSO mechanism and relatively low for market standards.

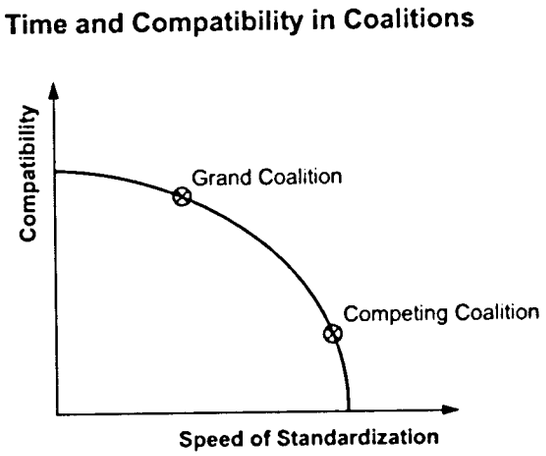


Figure: Time and Compatibility in Coalitions (Source: van Wegburg, 2004, p.20)

2.2 De-facto standardization

2.2.1 Factors favouring de-facto standards

Factors favouring de-facto standardization include (Grindley, 1995, p.64):

- Product Focus: The standards are aimed at products such as consumer electronics or computers and are not based on the policy agenda of a government or an authority.
- Speed: Standards can be developed faster than in formal standardization.
- Commercial Goals: The standards are set to achieve commercial benefits rather than being too technically biased.
- Clear Decisions: Agreement is much easier; hence decisions are clearer compared to formal standardization where it is usually difficult to achieve agreement.
- Design Variety: It is possible to achieve more than one standard so that the users have a choice in the selection, for example, IBM PC and Apple Computer.
- Open Process: The standard-setting criteria remain openly economical as opposed to the political and covert lobbying in formal standardization.

2.2.2 Creating de-facto standards by individual competition

This type of de-facto standard results when a market leader decides to develop a standard on its own (unilateral or stand-alone). The factors critical for unilateral standardization include (a) availability of large amount of resources and skills within the company; (b) the company being a technology leader in the industry; and (c) the company having close control over its technology.
Having adequate resources and competencies is one of the main reasons for a company to develop and sponsor its own de-facto standard. Such companies are motivated by the fact that creating a de-facto standard would allow them to have close control over the technology being set as the standard. Another reason companies may consider is the short time required for the unilateral standardization process compared with the possible delays caused by bargaining activities among participants in the case of consortia or alliances. A shorter standardization time is particularly important in securing the first-mover advantage in a market. Apple Computer is an example of a unilateral de-facto standard.

However, the attempt to create a de-facto standard by individual competition is not without disadvantages. First, the use of a substantial amount of resources for standardization would add a significant risk to the business. Second, the standardization process could divert important resources from core aspects of technology to develop and provide complementary products necessary for successful adoption of the standard. Also, unilateral standardization could increase the inertia of the market to accept the technology offered due to the fear of possible monopolistic behaviour of the company. This would, in turn, reduce the overall market size for the product.

For example, Apple Computer Company tried a unilateral standardization strategy for its Macintosh computer. At the beginning, this approach was quite successful due to the first-mover advantage, which was amply supported by its own complementary products such as software, printers, and other peripheral equipment. However, the introduction of IBM's PC as a result of the alliance between Microsoft and IBM eroded Apple's competitive advantage in the computer market. And Apple did not have enough resources to win the standards contest. The story of the 56k Modem provides another excellent example. US Robotics launched an innovative technology for the 56k Modem, but the sudden entry of an alternative technology to the market, known as k56flex, supported by several collaborative companies prevented US Robotics from creating a de-facto standard. This compelled US Robotics to form collaborations with other companies and later, resort to the mediation of ITU for setting a standard.

2.2.3 Creating de-facto standards by cooperation

The need for an individual company to cooperate with other companies in external standardization depends on reasons such as network externalities, installed base and the absence of a dominant company in the market. Standards add value by making it cheaper to buy complements, easier for users to switch from product to product and easier to use products in combination (see Section 2.1.3). Cooperation with other companies not only increases the number of suppliers providing compatible core products, but also leads to an enlarged complementary product market. When a number of companies adopt a compatibility standard for their products, the number of users having compatible products would also increase. This phenomenon is known as network externalities, and they create value for both the end users and for the suppliers. When companies realize that it is profitable to have a share of a larger market than a monopoly in a small market, they tend to cooperate with each other in defining common standards. If successful, a larger market enables a company to achieve economies of scale and thereby to improve its profitability. The VHS video cassette recorder format is an example of a de-facto standard developed by cooperation.

The involvement of two or more companies in developing or sponsoring a common standard (consensual standards) usually expands the installed base for a particular product. The larger the installed base of users, the more complementary products are developed according to the standard. A larger installed base with more complementary products improves the credibility of the standard, which reinforces the value for users. In turn, all these factors make the standard more attractive to new users; as a result, it creates an even larger installed base. This phenomenon is known as the 'dynamics of standardization' (Grindley, 1995, p. 27).

The need for a large installed base suggests that it is often difficult for a single company to establish its own technology as a market standard successfully. It is believed (Farrel and Saloner, 1985, p71) that only a dominant company (for example, Microsoft) that has substantial market power can successfully establish its own standard and remain incompatible with rivals. The absence of a dominant company in the market usually tempts companies to seek cooperation in establishing standards.

Specialized Standardization Organizations (SSOs)

A consensual de-facto standard can be created through a Sectoral or Specialized Standardization Organization (SSO) as well (De Vries, 1999, p. 169). Industry associations such as ASTM (American Society for Testing and Materials), SAE (Society of Automotive Engineers) and IEEE (Institute of Electrical and Electronics Engineers) belong to this category. Most of these SSOs are in fact industry associations.

Dynamics of Standardization

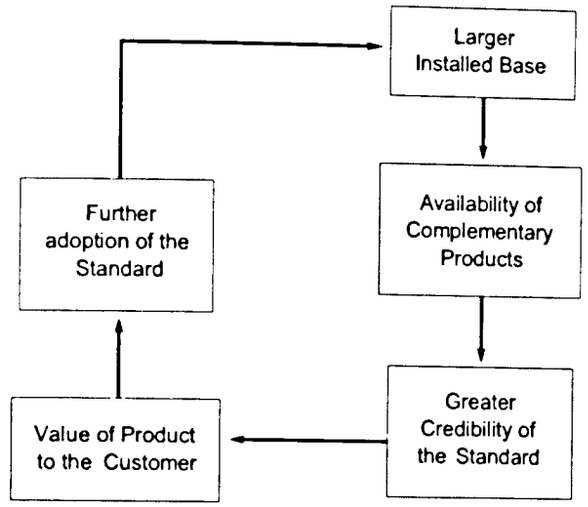


Figure: Dynamics of standardization (Source: Grindley, 1995, p.27)

SSOs are not formal standardization organizations (FSOs) as they do not have government-related accreditation or a formal relationship to a government. Some SSOs, however, identify themselves as consortia (De Vries, 1999, p.21). An example is World Wide Web Consortium (W3C), which along with IETF (Internet Engineering Task Force) carried out the standardization of the Internet (Krechmer, 2000, p.16). The success of the Internet, however, led to the elevation of IETF's status to a recognized standard development organization or RSDO (Krechmer, 2000, p. 16). Further, the difference between consortia and SSOs is characterized by the restrictions on participation: while consortia may choose their new members, SSOs, in general, allow any member meeting their criteria to join in. In fact, some SSOs adopt standardization processes similar to those of FSOs. For example, SSOs often welcome input from any interested party or country. In addition, some SSOs (e.g., IEEE) establish balloting groups to comment and vote on new standards. These groups are separate from the committees that actually write the standards. The work of members of the balloting group is carried out entirely by e-mail (Yokota & Weiland, 2004, p. 12).
The important characteristics of consortia and alliances will be discussed next.

Types of consortia and alliances

Consortia are groups of companies that are formed for the purpose of advancing a particular technology. In size, these are much larger than competing alliances. Their membership is usually not open to all interested parties and often participation is limited to manufacturers of the subject technology. The standard-setting process is more consensual than that of a competing alliance; it could be faster than the formal standardization process.

In the consortia arrangement, the sponsors jointly operate an organization responsible for designing, upgrading, and testing a standard. Success in a consortium is more likely when all organizations find a common interest in developing complementary products for their core products. Also, the large size of the consortia increases the market power, which, in turn, acts as a guarantee that the standard's integrity will be maintained in the future. The standards developed by consortia, like any other market standard, are somewhat less likely to be automatically accepted by the marketplace. In certain situations, there can be different consortia developing competing standards in the same subject area. Consortia, although more consensual in their approach to standardization, may still lead to standards contests. The development of the UNIX standard provides an excellent example. In this case, the participating companies went on to perceive consortia as a means of pursuing their own commercial interests and preventing unfavourable outcomes. This led to the creation of two consortia sponsoring different UNIX standards.

It is not always easy to identify differences between a consortium and an alliance. Some, in fact, use both these terms interchangeably for any group of companies involved in standardization activities irrespective of its size. Usually, an alliance is a handful of companies jointly developing or sponsoring a technology standard. Since the alliances are formed with the participation of a small group of companies, it is quite possible to have two or more alliances competing to establish their own technology standard in the market. The standards contest between VHS and Betamax was due to two competing alliances. In joining an alliance, companies usually prefer:

- to join a large standard-setting alliance in order to increase the probability of success in developing and sponsoring a standard; and
- to avoid allying with close rivals in order to maximize their own benefits from the standard (Axelrod et al, 1995, p. 1493).

As mentioned earlier, industry consortia and competing alliances are different with respect to the size and the time taken for standardization. The size or the number of participants in an industry consortium is large compared to that of a competing alliance and the standardization time for an alliance is usually shorter than that for a consortium.

Factors favouring the formation of consortia/alliances

Rapid technology cycle

The formation of a consortium is likely in situations where technology is changing rapidly. This option is taken by companies when the benefits from the standard are time-dependent. A standard is a specification for a particular technology (van Wegberg, 2004, p.28); technologies have life cycles and a given technology is usually superseded by a superior technology with time. The more time spent in standardizing such a technology, the less time remains for using it in marketable products. Because of this, companies prefer consortia/alliances in order to shorten the standardization time.

Dynamic market

Like technology, the market conditions can change rapidly on either the supply or demand side. In situations, where user demand varies for products rapidly, companies prefer consortia to formal standardization organizations (FSOs). A standard may be considered as a platform for new or improved products, and the products themselves have life cycles. Any delay in product launch, in turn, delays the inflow of revenues. In such markets, shorter standardization times are preferred.

Strong mutual interest

Consortia are preferred when there is a group of users and manufacturers with a strong mutual interest to develop a standard quickly so as to introduce a new product onto the market. Due to the lower compatibility in the rapid setting of standards, participation of close rivals is not welcome in such coalitions; however, the participation of distant rivals is more acceptable. The Compact Disc standard developed by Sony and Philips is an example of a standard developed by an alliance.

Factors affecting the selection of consortia/alliances

When more than one consortium or alliance is likely to be formed, a company's choice as to what alliance or consortium to join is influenced by three factors: potential strength in the alliance-setting process of competitors; capability of the competitors; and history of the alliance.

Potential strength of competitors

This factor is concerned with the number of companies that will strongly influence the standard-setting process. If there is only one company, the other companies have two choices: join together to oppose it, if they have a reasonable chance of dominating it; or join it, if it is too strong.

If the single company has strong IPR, the other companies are very likely to compete with it. In the case of several moderately strong companies and no dominant company in the market, there is a possibility that several competing

alliances will be formed. The absence of a dominant player was evident in the cases of Minidisc and DCC, which were sponsored by two competing alliances led by Sony and Philips-Matsushita.

Capabilities of the competitors
This aspect concerns whether the players have similar technical and commercial capabilities (close rivals) or complementary technical and market-related skills (distant rivals). Further, two companies whose core business is in a similar product (specialists) or two companies offering a range of similar products (generalists) in a given market could be considered as close rivals. On the other hand a specialist and a generalist could be considered as distant rivals. Competing alliances are likely to be formed by distant rivals, but are unlikely among close rivals. Sony and Philips came together to develop the Compact Disc (CD) standard. They were considered to be distant rivals in this market as they had different and complementary technologies: Sony owned better technology for identification and correction of errors, and Philips a superior technology for development of the CD (Chiesa et al., no date, p. 14).

History of alliance formation
History plays a major role in the choice of alliance (Axelrod et .al, 1995, p.1506), because the companies may use past and current strengths to assess each other. The size or strength of the companies and rivalries among them are based on the historical information about the companies. In the absence of such information, companies would make their choices based on the expectations of other companies' potential strengths and rivalries.

Business issues related to consortia/alliances

Structure
The size of organization, committee layers and their responsibilities vary from one consortium to another (Updegrove, 1995, p.145). The structure of consortia may also vary from simple to complex, depending on the above factors. For example, the X-consortium had a simple structure with only one layer or single governing group; all members had equal participation rights, although the membership fees varied from low (for end users) to high (for large companies).
In a complex structure situation, on the other hand, the members participate at different levels or layers depending on their technical concerns. In these consortia, members in different classes may have different sets of rights; the rights may not be always related to their economic contributions.

Funding
Consortia receive almost all their funds from participating organizations as membership fees, whereas national level SDOs (NSOs) usually receive significant government support (De Vries, 1999, p. 261-264) and international FSOs

receive the majority of their funds from member organizations and commercial activities. In some consortia, member organizations providing considerable amount of funds receive director seats, voting privileges, early technical access and other benefits (Updegrove, 1995, p.145). One of the challenges in forming consortia is therefore to give enough privileges to the largest contributors while providing adequate incentives for other interested parties to promote a common standard.

Treatment of IPR in consortia/alliances
IPR issues may arise within standard-setting consortia or alliances. Consortia often require that each participant accept an IPR agreement as a condition of participation in the standardization process. This is a significant advantage that consortia/alliances have over FSOs, particularly in situations where standardization time is a critical factor for participants. One of the reasons why companies prefer cooperative standard setting to the stand-alone approach is because they can benefit from the bandwagon effect created by collective action. This effect is more significant when two or more companies have crucial IPR (complementary patents) that must be contributed to develop a successful product. When multiple companies control patents essential to a standard, the complements problem may occur (Shapiro, 2001, p.5) as any manufacturer seeking to make a product complying with the standard must obtain licences from each IPR holder to avoid facing an infringement action. It is well known that the complements problem could not only lead to high licensing fees but could also be a waste of money if a company could only obtain licences for some of the essential and complementary patents. Cross-licensing and patent pools are two methods that can be used to minimize the complements problem (see Section 2.1.5). The MPEG-2 video compression technology is said to have about 100 patents, with the licences being issued through a patent pool.

2.2.4 Tactics to win standards contests

When there is more than one standard for a given core product, standards contests are possible. These are also known as standards wars or standards battles. These contests are costly and unpredictable and, in the end, one standard usually wins the market. Tactics are used by a company to force the market to adopt its own technology as a standard (Chiesa et al., 2002, p. 433). Tactics are one form of enabling strategies and are applicable to markets subjected to network externalities. The aim of each competing company would be to convince as many users as possible to adopt its specific technology, creating a bandwagon effect. There are six common tactics used in network markets, which include (Chiesa et al., 2002, p. 434; Besen & Farrell, 1994, p. 122-124; Grindley, 1995, p. 39-45):

- Second sourcing
- Building an early lead
- Influencing forecasts of future sales
- Attracting the suppliers of complements
- Product preannouncements
- Price commitments

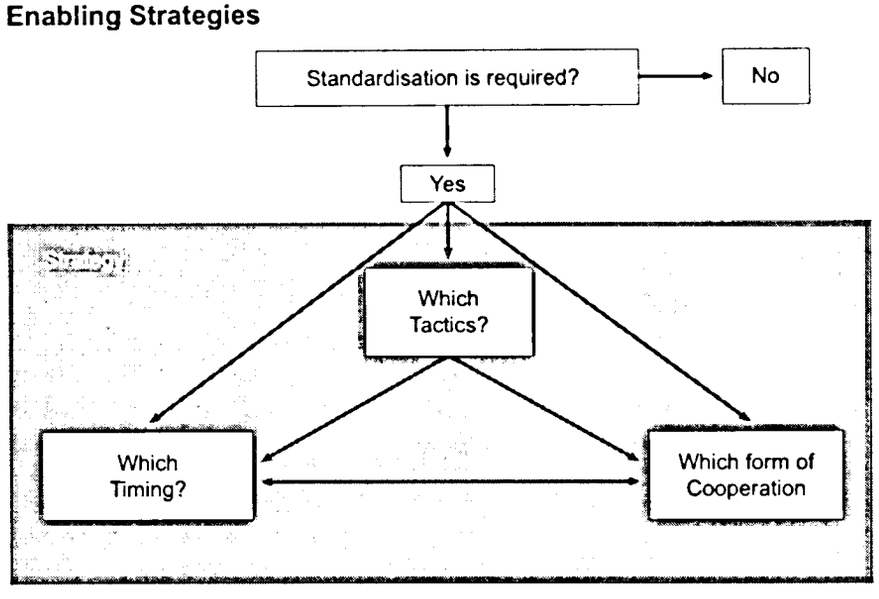


Figure: Enabling Strategies (Source: Chiesa et al., 2002, p.433)

Second sourcing

This includes actions that make one company's standard more attractive for others to use, such as: low-cost licensing; a commitment to share future development; and promising timely information to competitors (Besen & Farrell, 1994, p. 126). Low-cost licensing not only helps achieve cooperation between rivals, but also assures prospective buyers of 'second sources'. Chen and Ross (2000, p.329) see this type of licensing as an attempt to discourage competitors from continuing their search for superior technology; in a way this could be considered as bribing others to commit to a less competitive strategy. Intel's licensing of its microprocessor designs to AMD is a good example. Commitment to share future development is evident in JVC's strategy with respect to the VHS format, which in turn created a huge installed base for the standard, whereas Sony's decision to monopolize future product development discouraged the competitors from adopting the Betamax format.

Building an early lead

In network markets, users adopt the most widely diffused technology. Therefore, if a particular standard achieves a large installed base, it will also have a good chance of being adopted as a standard (Chiesa et al., 2002, p.434). However, this tactic is effective only when the sales are being continuously monitored by the users. Methods to build an early lead include: penetration pricing, ensuring adequate production capacity, and forming alliances with distributors and manufacturers (Grindley, 1995, p.42). Distribution channels are also important, as the product must be widely available once users become interested. Penetration pricing could stimulate potential users to buy the technology leading to rapid growth in the installed base. For example, Netscape gave away its Navigator free of charge to build an early lead in the market.

Influencing forecasts of future sales

In network markets, a company's market share and the level of current sales usually do not determine the winner of the standards contest (Besen & Farrell, 1994, p. 118), whereas user expectation of the ultimate size of the network is more crucial to the adoption of a specific technology. Users make purchase decisions based on their forecasts of future sales of a particular product. The main motive for prospective buyers is to avoid being stranded with a product based on an unsupported standard. If it is generally believed that a given standard is to be the contest winner, then users are likely to choose it. Companies influence markets by using advertising and promotion, and by educating the potential buyers in the use of what may be an unknown new product. MS -DOS is a good example of a standard that benefited from forecasts of future sales (Besen and Farell, 1994, p.118).

Attracting the suppliers and complements
The tactics to win standards contests are different from typical product competition; they are focused more towards the complementary product market (Grindley, 1995, p.72). The availability of complementary products increases the chances of a particular technology becoming the standard (Hill, 1997, p.9). A company seeking to introduce a new technology may encourage independent complementary production by providing information, education and training, and other incentives to co-producers; it may form partnerships with co-producers as well. Open standards are usually an effective way to attract suppliers of complementary products. Otherwise the standards leader may need to produce the initial complements itself, but this can be costly and may take a long time. By having several manufactures of complementary products, the product offers more choices to the users. They can shop around and buy cheaper complementary products that work with the core product.

Product preannouncements
Product preannouncements can be considered as another method of influencing expectations. They are often used to frighten off competitors or to gain time until a defending product is ready (Grindley, 1995, p. 43). Product preannouncements can reduce the impact of a competitor's innovation or at least confuse the market. IBM is believed to have used this tactic in the past, and Microsoft, some time later, used it to hamper the installed bases of their rivals (Besen & Farell, 1994, p.124). In certain industries, such as microprocessors, the entire contest sometimes takes place before the product is fully developed and ends when the majority of the users have incorporated the standard into their future designs.

Price commitment
If a company makes a strong public commitment to low prices for its products in the future, it can convince the potential buyers to adopt its product standard. Even if other competitors have set lower prices for their products at present, with a firm and substantial future price commitment, a company could influence buyers by suggesting they forgo a cost saving today to achieve greater savings in the future. Microsoft and US Robotics (56k Modem) made such price commitments to establish their standards successfully in the market. Similarly, RCA announced that the price of their colour TV would drop from $1000 to $500 within six months as a result of the NTSC colour TV standard. This had a significant effect on viewers' and broadcasters' expectations of the long-term size of the network of colour TV users (Besen & Farrell, 1994, p. 124).

2.2.5 Timing of de-facto standards

With respect to timing of standardization, a company should decide whether it would be advantageous to achieve a common standard definition before or after the introduction of the new technology in the market (Chiesa et al., 2002, p.435). Broadly speaking, the timing of standardization can be ex-ante or ex-post. Ex-ante is where a common standard is developed before the new technology, and ex-post is where the technology is introduced before establishing the relevant standard. Ex-ante is preferred where there are competitors developing alternative technologies or the technology standardized is easy to imitate, whereas ex-post is suitable when there are no such competitors developing alternative technologies and the company is a dominant company in the market. Another important point is that the ex-ante strategy leads to anticipatory standards, giving companies a 'head start' in developing products that would be valuable in global or international markets. These are considered to be a prerequisite for sustaining a company's competitive advantage (Betancourt and Walsh, 1995, p.120). On the other hand, retrospective (De Vries, 1999, p. 212) or responsive standards are used with the ex-post timing to standardize a well-established technology or codify the reality that is widely used. Ex-ante was successful in CD standards, but was a failure in the case of DVD; ex-post timing was successful in the QWERTY keyboard layout, but was a failure in the case of Minidisc and DCC.

2.2.6 Continuation strategies with de-facto standards

Establishing external standards is not enough; companies must adopt continuation strategies within such standards, if they are to be successful. Several continuation strategies are described in the following subsections (Grindley, 1995, p.48-52; Shapiro & Varian, 1999, p.21-27).

Degree of openness
The market share enjoyed by the leader during the early stage of a new de-facto standard gradually erodes as competitors enter the market. Although, at the time of establishing the standard, the company may have initially increased the degree of openness in order to improve the total market or the installed base, its market share and profits can go down with time as a result of competition.
In order to improve its competitive advantage, the leader may tighten the proprietary control it has over the standard-using methods such as restricted access, reduction in the number of licences issued, and increased licence fees. However, the increase of proprietary control or 'closing' of an open standard may not be easy to implement and may even have disastrous consequences. As users generally resist changes in technology, they might turn to other manufacturers offering cheaper substitutes. Therefore the installed base with

restricted access may rapidly decrease, eventually pushing the product out of the market. IBM's introduction of a proprietary PS/2 computer system in the late 80's is a good example of an unsuccessful attempt to increase proprietary control.

Super-compatibility
The leader may also do quite the opposite: increase the compatibility of the product in the hope of enlarging the installed base for greater network effects or network externalities. In this way, the company may be able to benefit from an increased market share and hence achieve greater profits. Super-compatibility is achieved through the reduction of non-standard features of the product so that it encourages potential purchasers to buy the product and have greater connectivity, portability and use of complementary products (see Section 2.1.3). Further, the company can now concentrate more on the technological development of the standard features of the product to achieve a competitive advantage over its rivals. Hewlett-Packard is well-known for using open standards and attempting to capture the market through the technological improvement of standard features in its products.

New products based on standards
This is simply using the established standard to create new products. The main advantages of this strategy include the use of well-established or proven technology for product development and the 'ready-made' installed base of complementary products to support the new product. The leader of such a new product can achieve high profit margins, a larger market share, and other advantages available for any original manufacturer. Examples of new products (better known as 'spin-offs') include Camcorders from VCR standards and the CD-ROM from CD standards.

Technical leadership
Instead of only competing within an established standard, a company may expand its competitive advantage through technological development of features outside the standard or even expanding the original standard. This strategy, in fact, is more suitable for the developer (leader) of the original standard, but others too can innovate outside the standard. To achieve market power, these new features must be compatible with the original standard. Technological development of new features gives a company the first-mover advantage and an emulation lag to expand its market and maintain higher profit margins. In the late 80's IBM developed interface standards such as the Video Graphics Array (VGA) as a continuation strategy to gain control over the company's original personal computer (PC) standard.

Complementary assets
When a product developed to an established standard becomes commoditized due to the presence of a large number of manufacturers, a restricted number of ways of differentiating the product and low profit margins, the competition in the market could turn to a quality and price battle. In such a situation, the continuation strategy would be to depend more on the complementary assets such as the company's capabilities in high-quality manufacturing, effective marketing and efficient distribution of its products.

Vertical integration
A company having a significant installed base for its product may seek to leverage into adjacent product areas in order to make use of a unique opportunity to create value for its customers. For example, a core product manufacturer could vertically integrate with a business involved in a complementary product. However, care should be taken to encourage healthy competition in the complementary product market as its continuity could determine the market for the core product as well. The other point to remember is the presence of legal limits to such vertical integration (safeguards against possible anti-competitive behaviour of companies). The acquisition of CNN by Time Warner is a good example of vertical integration. In this case, the Federal Trade Commission (FTC) forced Time Warner to agree to carry a rival news channel on its cable network as well.

2.2.7 Problems with de-facto standards

Losing standards contests
The loser of a standards contest usually loses the first-mover advantage. It also runs the risk of not being able to survive in the market. In order to bridge the technological and knowledge gap between itself and the winner, the loser may subsequently have to spend large amounts of resources. In addition, the loser has to compete within the boundaries set by the competitor whose standard has been accepted by the market.

Duplication of development costs
Development of de-facto standards requires a high level of commitment and a large level of investment by individual companies. When there is more than one de-facto standard in the market, the standards compete with each other, yet without any guarantee of winning the standards contest. As there would be only one winner in the end, the investments and efforts of the losers may go to waste without any return to them (Grindley, 1995, p.58).

Fragmentation
If it takes a long period for a winner to emerge in standards contests, then there may be several product standards. This can lead to fragmentation in the market where all users suffer by being locked in to several standards with small installed bases such as colour TV standards. Each may have enough of a niche to survive, but not enough installed base to achieve full network benefits. The market as a whole is held back by not having a single, fully supported standard, or at least a few well-supported ones. Such a fragmented situation in standards can cause high costs of core products and complementary products as it is not possible to achieve economies of scale (Grindley, 1995, p.58).

Stranding
Users of minority losing standards in standards contests may be 'orphaned' or stranded with a poorly supported standard such as the Betamax video cassette recorder. There may be few complements available, but the users are locked in by their investments. The user cannot adopt a new standard with superior technology or wide acceptance due to high switching costs. In some cases this problem may be reduced by the development of converters.

Technical inferiority
The winner in a standards contest may not always be the most technically advanced product; there are many reasons other than technical superiority that ultimately determine the winner. Because of this, a relatively inferior standard may emerge as winner and all the users may be locked in to such a standard forever. The QWERTY keyboard provides a classic example of such a situation. It is widely believed that there are other keyboard layouts, for example Dvorak (Farrell and Saloner, 1985, p. 71), which are better than the QWERTY keyboard although they have not been successful in the market.

2.3 Formal standardization

Recognized standards development organizations (SDOs) or Formal Standardization Organizations (FSOs) develop de-jure standards. Such FSOs include:

International Level:
- International Organization for Standardization - ISO
- International Electrotechnical Commission - IEC
- International Telecommunications Union - ITU

Regional Level (examples):
- European Telecommunications Standards Institute - ETSI
- European Committee for Electrotechnical Standardization -CENELEC
- European Committee for Standardization - CEN

- North American Free Trade Agreement (NAFTA)
- Pan American Standards Commission (COPANT)
- Common Market of the South (MERCOSUR)
- Association of South East Asian Nations (ASEAN)
- African Organization for Standardization (ARSO)

National Level (examples):
- Deutsches Institut für Normung (DIN)
- British Standards Institution (BSI)
- American National Standards Institute (ANSI)
- Association Française de Normalisation (AFNOR)
- Nederlands Noramalisatie-instituut (NNI)

The standardization process of a formal SDO is characterized by openness, due process, and consensus, which assure fairness and equity among participants (Yokota & Weiland, 2004, p.7).
Companies in every industry and of every size are beginning to realize the importance of taking part in the formal standardization process. It is widely believed that if a company does not participate in the standardization process, it will have to play by its competitors' rules.

Market structure and probability of formal standardization

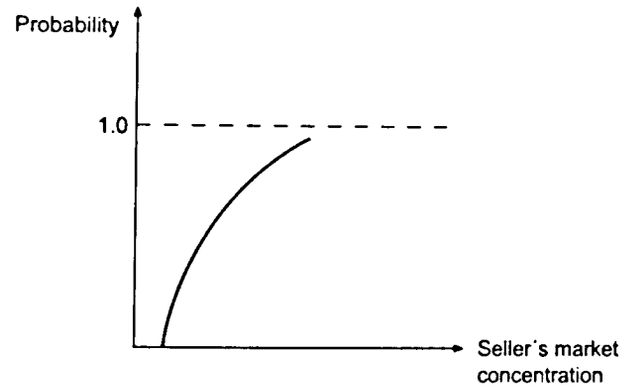


Figure: Market Structure and Probability of Formal Standardization (Source: Link, 1983, p. 396)

2.3.1 Factors favouring formal standardization

Formal standardization can be more difficult, time-consuming, and costly than de-facto standardization. However, in certain instances, it may be the only way for the standard to be accepted by the industry. For example, large customers such as governments may prefer ISO standards to IEEE standards and IEEE standards over standards developed by consortia. The probability of a company opting for formal standardization would depend on the market concentration: in an atomized market (perfectly competitive environment) consensus is unlikely; whereas, in a concentrated market (monopolistic environment) cooperation is more likely as companies would realize their interdependence in achieving network externalities (Link, 1983, p.395). In general, formal standards are preferred by companies for the reasons given in the following subsections.

Enlargement of installed base
As formal standardization literally involves all the possible parties interested in standardization, a formal SDO (FSO) can be seen as the ultimate development of cooperation among companies. Formal standardization therefore creates the greatest possible installed base. This helps wider diffusion of the standards and increases the probability of success for the standardization. However, the commitment of participants is necessary for success, and if any companies are participating only to delay the standardization process, the FSO would be unable to develop a single standard.

Minimization of monopoly
The formal standardization process assures customers of the presence of many competitors who supply products to the market. This reduces the monopoly or opportunistic behaviours of manufacturers or suppliers in the market.

Reduction of risks and costs of standardization
The risks in standardization include the failure to establish one's own standard in the market. As a result of standards contests, usually only one out of two or more standards developed by competitors is adopted by the market. Formal standardization through the participation of all competitors in developing a single standard avoids standard contests and hence the risk of failure. For this to happen, however, there must be a high degree of compatibility of the existing technologies related to the standard being developed. This makes it easier for the companies to compromise in arriving at a common or single standard. Since companies participating in the process share the total cost among themselves through the funding mechanism adopted by the FSO, formal standardization reduces the standardization cost of individual companies as well.

Equity among big and small companies
The formal standardization process allows not only large companies, but also small companies to participate actively with some level of decision power in

the standardization process. This decision power must be well distributed, but not balanced in such a way that it would only lead to a stalemate.

2.3.2 Strategic selection of standards development organization

A company's choice to support International (Global) Standardization, de-facto standardization or National Standardization seems to depend on two factors: (a) whether the company is a leader or a follower of the technology being standardized; and (b) whether the cost of vote recruiting of the FSO concerned is high or low (Austin and Milner, 2001, p. 417).

Leader or Follower
A technology leader is a company owning a proven, leading-edge technology, which others do not have. In addition, such a company may have IPR or patents that are essential to manufacture a product to a given standard. Leaders usually have two choices regarding standardization: to create a global market standard or to establish a formal standard through an international FSO. The objective of the leader is to exploit the global market, and its decision is likely to be affected by the cost of vote recruiting for the international FSO.
A technology follower, in contrast, neither owns a proven, leading-edge technology nor essential IPR. Followers usually prefer to create global standards that differ from those used by the leaders through an international FSO; if this seems impossible, they support the development of national (or regional) standards. The objective of the follower is to create trade barriers for rivals, and here again, the company's decision is likely to be affected by the cost of vote recruiting for the international FSO.

Cost of vote recruiting
The cost of vote recruiting is the cost incurred by a company to recruit 'voters' in an FSO; this is to convince the other participants to vote for the standard that the company prefers. The cost of vote recruiting may depend on several factors related to the FSO, which include: its decision-making rules; exclusiveness; size of its membership; and its scope of coverage. If an FSO uses unanimity as its decision-making rule, the cost of vote recruiting could be very high as a company would need to recruit all the participants to vote for its preferred standard. On the other hand, an FSO using the simple majority-rule in its decision-making process would have a relatively low cost of vote recruiting. The recruiting of votes is even more difficult when the number of actors is large. Further, when the number of actors is large, the scope of the standard becomes broader; in other words, the standard provides greater market access. The leaders usually prefer consensus-based FSOs due to their non-exclusive membership (or inclusive membership), and democratic standardization process that minimizes antitrust claims later. In contrast, followers prefer FSOs with exclusive membership to create a group of similar followers to prevent the adoption

of standards supported by leaders. When unanimity-based or consensus-based international FSOs prevail in a given industry, technology followers may attempt to use national or regional institutes to develop standards they prefer and thereby create trade barriers for technology leaders.

Strategic Selection of Standards Development Organization

Type of Firm	Institutions: High Cost Vote Recruiting	Institutions: Low Cost Vote Recruit
Leader	Global Standards (With inclusive Cooperation)	Market Standards (De facto Standards)
Follower	National Standards	Regional or Global Standards (With Exclusive Cooperation)

Figure: Strategic Selection of Standards Development Organization (Source: Austin and Millner, 2001, p. 153

2.3.3 Stakeholders in formal standardization

Types of stakeholders or actors

The stakeholders in formal standardization include: producers, users, consumers, governments, and other interested parties (De Vries, 1999, p. 24-29).

- Producer: A member who represents a company manufacturing a product in accordance with the particular standard concerned.
- User: A member who represents a company or an organization purchasing a product (other than for private use or household purposes) affected by the standard concerned.
- Consumer: A member who primarily purchases a product affected by the standard concerned for private use or household purposes.
- Government: A member who represents a country through its National Standardization Organization (NSO) or any other regulatory agency in standardization committees. (It should be noted that governments are very often major users as well.)
- Other interested party: A member who cannot be classified under any of the above types and usually represents consultants, scientists, and academia.

Within formal SDOs (FSOs), such as ISO and ITU, the work is done through Technical Committees (TC), Subcommittees (SC), and Working Groups (WG). In fact, the use of SCs and WGs in the standardization process is left to the decision of the respective TC (McDowell, 2004, p. 11). The stakeholder participation within these committees depends on the rules and regulations (Due Process) of the particular FSO concerned.

As a standard originates from a technical committee and its subcommittees and groups, it is important to know how these committees are actually formed by the above stakeholders. Very often, the main actors in the standardization process are producers and government representatives. The users (other than governments) are usually underrepresented in standardization committees; in theory, however, they are free to participate in the standardization process.

Participation Rate in Standardization

Institution	Vendors	Consultants	Academia	Comercial Users	Govt. Representatives
ITU	76%	4%	4%	-	16%
ISO	43%	-	43%	-	14%
IETF	56%	6%	19%	-	19%
Total	61%	3%	18%	-	16%

Figure: Participation Rate in Standardization (Source: Jacobs, 2001, p.3)

According to a case study (Jacobs et al., 2001, p.3) carried out on committee members of ISO, ITU and IETF (Internet Engineering Task Force), the largest category of actors (around 60%) participating was vendors and service providers (producers), followed by government representatives and academics and researchers.

Actors and standardization time

Although formal standardization is based on wider participation and consensus, it is often criticized for the longer times required for the process. If participation is extremely time-consuming, only large companies are likely to take part in the process as their commercial interests are high in the standard (Swann, 2000, p. 42). In contrast, small and medium enterprises (SMEs) may find it too expensive to spend long period of time on standardization, and may decide to take part only when the time spent is relatively lower due to the direct and

opportunity costs of participation. The direct costs include transport and other expenses, and opportunity cost is the lost time that could have been used for other purposes. The governments, being the largest users, place themselves in between big companies and SMEs. Although the users of any particular standard usually outnumber the producers, their participation is greatly discouraged by the costs involved. The actual time taken to reach consensus on a particular standard is determined by the demand and supply for participation in the standardization process (Swann, 2000, p. 42). The demand is defined by the number of actors willing to become involved in the process at a given level of standardization time; the supply is the maximum number of actors possible for a given standardization time. As the cost of participation is positively correlated with standardization time, it is believed that by offering subsidies to SMEs and users, the rate of participation could be improved.

Standardization Time and Participation

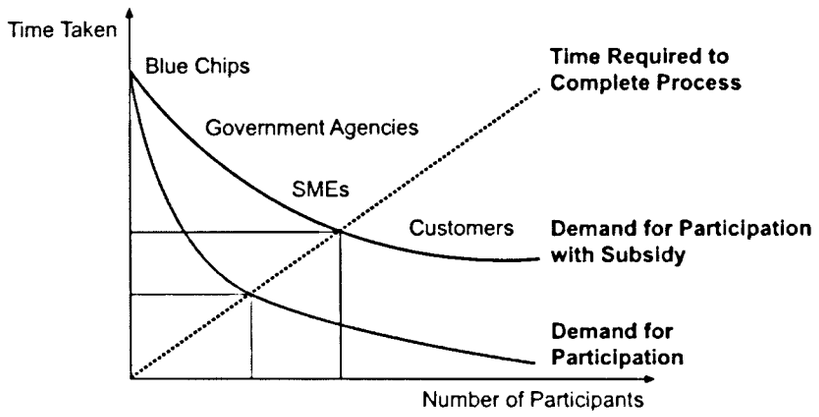


Figure: Standardization Time and Participation (Source: Swann, 2004, p.41)

2.3.4 Participation in the formal standardization process

Participation in international FSOs

As mentioned earlier (Section 2.3.2), technology leaders prefer setting international or global standards that allow them to exploit or maintain their lead (Austin & Milner, 2001, p. 413). The decision to develop global standards through international FSOs would, however, depend on the cost of vote recruiting and the decision-making rule of such FSOs; technology leaders usually prefer FSOs with a consensus-based decision rule as they form inclusive cooperation and

give them the opportunity to prevent technologies promoted by their rivals from being adopted 'as the standard. Most countries are members of international FSOs like ISO and IEC through their National Standards Organizations (NSOs). As a result, they are already well-positioned to participate in the development of international standards at the different levels available. Companies interested in participating in standardization through international FSOs must also do so through their National Standardization Organizations (NSOs). Any member country can, if it wishes, become a full voting member (Participating Member or P-member) of an ISO or IEC technical committee (TC). Countries can also choose to be Observing Members (O-members). O-members can attend meetings, but cannot vote; however, they receive the full collection of information about the TC's activities so that they can remain up-to-date with its progress and activities (Yokota & Weiland, 2004, p.12). Subject to the availability of resources, country representatives, for example DIN of Germany, can send delegates and subject-matter experts to TC meetings and to meetings of their subcommittees and working groups.

Usually, the plenary meetings of TCs focus on administrative and cooperation issues, information sharing about the general subject matter of the TC, and the approval of new standards proposals and drafts to be balloted. However, attendance of TC meetings is not mandatory. On important issues, like the formal approval of draft international standards, votes are taken by correspondence, and all P-members can vote even if they do not attend plenary meetings (Yokota and Weiland, 2004, p. 12). Standards development in FSOs is carried out by subcommittees (SC) and working groups (WG), which usually meet more often than the TC as a whole. P-members can send experts to these meetings. However, countries are regarded as fully participating in the development of a standard even if they are only able to review and comment on drafts and eventually participate in the voting. Even this level of participation is considered a valuable contribution to the development of a standard, and ensures that a country's particular requirements are included in the standard as it is developed. Any country can select a level of participation or observation for each separate standards development activity.

Participation in regional standards organizations

The regional standardization organizations play the following roles in the standardization arena (Lusby, 2000):

- Serving as a forum for sharing information and experiences.
- Adapting international standards to local conditions.
- Developing regional standards, particularly when it is difficult to generate interest or support at the international level for a standard that satisfies a regional need.
- Serving as an intermediate step to harmonization with international standards.

The objective here is not to develop regional standards that are incompatible with the rest of the world, but to make regional standards development become part of the international process. However, it is not clear whether regional standardization always achieves this objective. In particular, when companies in the region who are technology followers fail to set the technology they promote as the standard through an international FSO, they tend to look for regional FSOs to set regional standards. Regional FSOs often use exclusive cooperation and low-cost vote recruiting (through majority decision-rule) in the standards-setting process. For example, in CEN, CENELEC, and ETSI, which are the European equivalents of ITU, IEC ISO respectively, the standards decisions are not made on the basis of consensus, but through a system of individual weighted voting. The attempts by Philips and Thompson to establish MAC (Multiplexed Analog Components) technology as HDTV (High Definition TV) standard through European FSOs is a good example (Austin & Milner, 2001, p.424). The two companies also blocked the international standardization process initiated by Sony (the technology leader) through the ITU, making use of its consensus-decision rule. Some of the regional FSOs are briefly described below.

European Region:
CEN, CENELEC, and ETSI are the main FSOs in the European region. Most standards prepared by them are at the request of industry. The European Commission (EC) can also ask them to develop standards in the context of implementing EU legislation.

American Region:
The most important organizations involved in standardization in this region include: NAFTA (North American Free Trade Agreement); COPANT (Pan American Standards Commission); and MERCOSUR (Common Market of the South). NAFTA is involved in developing uniform standards and harmonizing safety and other standards in the North American region. COPANT is a non-profit organization with the objective of promoting the development of technical standards and related activities in North America, Central America, South America and the Caribbean region. MERCOSUR is an organization for improving the economies of its member countries, namely, Argentina, Brazil, Paraguay, and Uruguay.

Other Regions:
Other regions such as Asia and Africa, too, have their own regional organizations to deal with standardization activities. ASEAN (Association of South East Asian Nations) is very active in the region in standardization through its Consultative Committee for Standards and Quality (ACCSQ). ARSO (African Organization for Standardization) is an inter-governmental standardization agency comprising African National Standardization Organizations (NSOs); its mission is the promotion of quality through coordination and harmonization of standards and conformity assessment in Africa.

Participation in national standards organizations (NSOs)
Each country has its own national standardization system. At the national level, standardization work is generally conducted by the national standards organization (NSO) through standards committees. These committees or working groups are made up of qualified representatives of the industrial circles, research institutes, public authorities, consumer or professional bodies. Most national standards organizations (NSOs) are members of regional and international FSOs and are entitled to represent their countries on the international or regional committees dealing with a specific subject matter. The NSOs also offer the opportunity for companies to participate in regional and international standardization activities as part of their delegations.

Companies participate in NSO standardization activities to set national standards. Sometimes NSOs are used by companies to create trade barriers to international technology leaders (See Section 2.3.2 for further discussion). Companies that are technology followers are likely to choose NSOs when the international or regional FSOs have high costs of vote recruiting. This way they can create highly effective technical barriers to trade (TBT) for international competitors (Austin and Milner, 2001, p. 418). A classic example can be seen in the standardization of colour televisions. The attempt of RCA, as the technology leader of colour television, to globally promote the NTSC standard was thwarted by the French and German competitors (technology followers) through their national level colour TV standards CSF and Telefunken.

2.3.5 Benefits of participation in formal standardization

Companies can derive many benefits from participation in the standardization process of FSOs. The following are some of these benefits (XenCraft, no date):
- Influence on the standard's content
- Early access to specifications
- Reduction of commercial risks through lower development costs
- Improved ability to identify future trends
- Development of personnel by giving them the opportunity to work with leaders in the field
- Opportunity to participate in exclusive events such as workshops and conferences
- Ability to participate in promotion of the standard
- Greater understanding of the standards and their underline designs
- Enhancement of corporate image as an industry leader
- Information straight from the source
- Contacts with other specialists in the industry.

European Standards Organizations

Standardization Area	International Organization	European Regional Organization
Spectrum and Broadcasting Rules	International Tele-Communications Union (ITU)	European Tele-Communications Standard Institute (ETSI)
Electronics	International Electrotechnical Commission (IEC)	Comite Europeen de Normalization Electrotechniques (European Committee for Electro technical Standardization committee - CENELEC)
All other	International Organization for Standardization (ISO)	Comite Europeen de Normalisation (European Committee for Standardization - CEN)

Figure: European Standards Organizations (Source: Yokota and Weiland, 2004, p.6)

2.3.6 Treatment of IPR in formal standardization

Intellectual property rights associated with formal standardization is a serious issue and FSOs have different policies for dealing with the incorporation of IPR into the standards that they develop. During the development of technical standards, the FSOs usually require participants to disclose if there are any essential patents or blocking patents needed to comply with the standard. If so, the permission of the patent-holder is required and this simply means signing licence agreements and paying royalties to the patent-holder. Many FSOs discourage the use of IPR in standards; however, there can be exceptional cases which are justified by technical reasons. In such cases, the technical committee of the FSO may ask the patent-holder to agree to negotiate licensing fees with other users on reasonable, fair, and non-discriminatory terms and conditions (these are generally known as RFND or RAND terms and conditions). The negotiations usually take place outside the FSO, and the standardization processes may be delayed until the negotiations are complete (Krechmer, 2000, p. 17). Some FSOs may even go beyond RFND terms and conditions, requiring the patents to be licensed free of charge or on a royalty-free (RF) basis.

2.3.7 Problems with formal standardization (Grindley, 1995, P. 61-63)

Difficulty in reaching agreement

The presence of many actors in formal standardization makes it difficult to reach agreement in the process. The situation is complicated by the involvement of the participants' commercial interest. Even if the participants agree on a common standard, it may not have their total commitment. Such standards are of less practical value and this may still subsequently lead to market standards The committee structures used by FSOs are also partly responsible for difficulty in reaching agreement. As FSOs are very often involved in the development of quality and performance standards, they may face problems in developing compatibility standards that are influenced by more complex commercial interests.

Technical bias

The formal standardization process is influenced more by the technical aspects of a standard than its commercial requirements. Historically, the well-established standards are not always the most technologically advanced: success very often depends on other aspects such as broad support, quick adoption in markets and complementary investment. This technical bias could be partly because of the difficulty in obtaining commercial information and partly due to the influence of the existing quality and safety standard-setting practices in FSOs.

Lobbying process

The involvement of an FSO in formal standardization adds another actor to the standardization process: the FSO itself. This can shift the focus of the competitors from the standard itself to influencing the FSO in their way. The standardization process therefore could change from economic to political. The FSO's lack of information on commercial aspects makes it more dependent on the information supplied by the participants, which could in turn make lobbying an important factor in the standardization process. Companies may also use the lobbying process to make the FSO adopt market standards as formal standards. The attempts made by RCA of Unites States to adopt NTSC technology internationally through the ITU is a classic example (Austin and Milner, 2001, p. 420). The lobbying process is clearly visible in this case as 18% of the documents submitted to ITU for standardization of colour televisions came from the US delegation (of which 22% were representatives of RCA) as opposed to 8% from France and Germany who promoted the SECAM and PAL technologies respectively.

External policy agenda

Sometimes the standards authority may influence the standardization process with its own policy agenda. In particular, standard-setting processes at national level are more vulnerable to this as there may be attempts to promote domestic industry through standards and even to impose trade restrictions or barriers

on international companies (see Section 2.3.2). Such an external policy agenda may lead to standards that are inefficient and unacceptable to the market. According to Grindley (1995, P.63), the telepoint standard had an external policy aim to promote UK manufacturers and influence telecommunication competition, but the standard later became unworkable.

Timing
This is an aspect discussed over and over in this lecture. Formal standardization usually takes a longer time than de-facto standardization. One of the important aspects in any standard is the time taken to for its development. Due to the involvement of a large number of actors, the FSO standard-setting process is notably slow. Such delays in establishing necessary standards are not acceptable in many industries where technology and the industry structure change rapidly. Another point is the inability of the FSOs to keep abreast of technological and market developments, which may result in standards unacceptable to the market. It is also possible that companies involved in standardization may purposely delay the development process for commercial reasons; this can happen particularly in FSOs with unanimity as the decision-making rule, which offers protection to minority stakeholders. Some FSOs adopt simple majority decision-making rules to avoid such delays.

3 Concluding remarks

The aim of this lecture was to present the necessary knowledge on the use of external standardization as a corporate strategy. Although every effort has been made to ensure its completeness, it should not be considered as an exhaustive description of the subject. Readers are therefore encouraged to venture more deeply into the subject area by using the resources given at the end of the lecture and on the Internet to find out what is possible with external standardization and where its limits lie. They must bear in mind that, as Arthur C. Clark, the renowned science fiction writer, once remarked: 'the only way to know the limits of the possible is to go beyond them into the impossible.'

The subject area known as Strategic Standardization Management (SSM) is a good point for readers to start their journey. SSM is not just about standards; it is about leveraging all aspects of standardization to improve a company's global competitiveness (Betancourt and Walsh, 1995). Readers may find this concept very useful, particularly in the wake of a paradigm shift in standardization. In other words, the use of the standards has begun to shift from company standards to external standards (national and international standards) and similarly, the purpose of standards, from the predominantly technical to the business-oriented.

Finally, the intention of these concluding remarks is not to give external standardization more prominence than it actually deserves. Different aspects of standardization presented in other lectures are of equal importance; together, they provide the reader with a more complete picture of a vast subject.

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5 Glossary

Anticipatory standards
These are product standards created before wide-spread acceptance of the product.

Battle of sexes
This situation occurs when each company interested in standardization would like to be compatible with competitors' technology rather than 'going it alone'. Therefore, they wish to compete within one standard, but they disagree about what the standard should be.

Continuation strategies
The approaches used by a company to compete effectively on an ongoing basis once a particular standard has been established.

Cloning
This is the act of copying a technology standard (specifications of a product). This may be done with or without payment of licence fees depending on whether the standard is proprietary or open. For example, 'IBM compatible' computers are called 'clones' of the IBM open standard for personal computers.

Close rivals
These are companies with similar market segmentation profiles; each of them has a strong incentive to promote its own technology as a standard in order to maintain and grow its installed base (Axelrod et al., 1995).

Commoditized
A market is known to be commoditized when the competition between companies is based on more conventional dimensions such as price, quality, and product features rather than between their technologies.

Competitive advantage
The advantage a company has over other competitors in the same market, in terms of factors such as high quality of products, low cost of production, sound technology, customer relationships, installed base, and efficient distribution channels.

Complementary patent
Same as essential patent.

Complementary products
These are products or accessories that can be used with the core products manufactured to a given standard. For example, VCR tapes, software and automobile parts, which are often supplied by a separate industry.

Complements
Same as Complementary products.
Complements problem The situation created when multiple patent-holders block a given product from being manufactured (Shapiro, 2000).

Consensus
This means that all views are listened to, objections are addressed, and general (may not necessarily be unanimous) agreement is required to approve a standard (Yokata and Weiland, 2004).

Copyrights
Statutory rights granted under the Constitution (law) to an author for a limited time, to control the reproduction or other specific use of an original work of authorship in order to encourage further creative expression (Smoot, 1995).

De-facto standardization
Standardization carried out by parties other than Formal Standardization Organizations (FSOs).

De-jure standards
These include both mandatory standards (promulgated by legislative bodies) and voluntary standards (developed by FSOs) (Chiesa, et al., 2002). Some, however, limit the de-jure term only to the first type or those established on a legal basis.

Distant rivals
These are companies with different market segmentation profiles; they do not meet head to head in the market. They have different technical and market-related skills.

Dominant company
A company that controls a technology that is established as a standard can be called a dominant company. A dominant company is usually in a very good marketing position. Such a company may also have a large installed base and a reputation for setting standards (Besen and Farrel, 1994).

Due process
Standards are developed according to clearly stated rules and through a series of well-defined stages from initial drafts through final publication. This typically involves multiple layers of review and approval (Yokata and Weiland, 2004).

Economies of scale
Standardization increases the confidence of buyers (users) and thus increases their demand for a particular product. This enables larger-scale production and automation of the production processes. The cost reduction and other benefits achieved though larger-scale production are known as economies of scale.

Emulation lag
The time between the introduction of a new product by a company and the development of similar products by its competitors.

Enabling strategies
The approaches used by a company for winning a standards contest, which include correct timing (ex-ante or ex-post); form of cooperation; and tactics.

Entity
Any concrete or abstract thing that exists, did exist, or might exist, including associations among these things such as a person, object, event, idea, or process (De Vries, 1999, p. xix).

Essential patents
The patents essential to comply with a given standard (i.e. no substitutes are available for them).

Exclusive membership
A group that can increase its collective good by seeking to exclude other interested parties.

External standardization
Standardization of products or technology carried out in network markets which focuses mainly on business issues such as product acceptance and new market entry rather than those related to efficiency, productivity, and cost reduction at company level.

External standards
Standards established in a market to achieve compatibility.

First-mover advantage
The benefits of a momentary monopolistic power soon after the introduction of a new standard.

Formal standardization
Standardization carried out in formal standardization organizations (FSOs).

IEEE
Institute of Electrical and Electronics Engineers.

Inclusive membership
A group with an incentive to include as many interested parties as possible.

Innovation
This is the act of creating things such as new product designs, new production processes, or new market approaches.

Intellectual property rights (IPR)
These include patents, copyrights, trademarks and trade secrets, of which the patents and copyrights are often associated with standards. Thus when standards incorporate technologies that are to be protected, IPR provide a tool for controlling the use of standards.

ITU
International Telecommunications Union.

Locked-in
The situation faced by companies who have adopted a standard where it is impossible to change to another standard due to the high switching costs. See also lock-in effect.

Market standard
Same as de-facto standard.

Network externalities
In markets characterized by network externalities (network markets, the benefits that the customer derives from a product increase with the number of other customers purchasing similar or compatible products. For example, the benefits for a person purchasing a telephone, increase with the number of other people using telephones. (Katz and Shapiro, 1986). See also externalities.

Network markets
Markets where users like to buy products compatible with those bought by others.

Open standards
Open standards are those considered to have diffused widely and adopted by most companies in the market. The companies using them are not required to pay for the right to manufacture products in accordance with the standard, other than nominal fees (if any) imposed by the Formal Standardization Organizations (FSOs). These are usually de-jure standards, but there may be open de-facto standards, as well (for example, IBM PC standard).

Openness
Any interested party is allowed to participate and express views (Yokata and Weiland, 2004).

Patents
Statutory rights granted under Constitution (law) to an inventor for a limited time, for the exclusive use of the invention in order to encourage further invention (Smoot, 1995).

Positioning strategy
The decisions taken by a company to develop its own standard or to adopt an external one, and whether to stick to a proprietary or open technology.

Proprietary standards
These are de-facto standards protected by IPR, and therefore, any party, planning to use the standards, must obtain rights from the holders of copyrights and/or patents.

Quality standards
There are two types of quality standards: minimum attributes standards and product characteristics standards. Minimum attributes standards cover basic product requirements for measurement and minimum quality such as packaging, sizes, and produce grades. Product characteristics standards are related to standardization methods such as common production technology and components, which reduce development and manufacturing costs. (Grindley, 1995, 22).

Responsive/retrospective standards
These standards are created after the product has been established and sold with some success.

SAE
Society of Automotive Engineers.

Stakeholder
An interested party; a party involved in standardization or affected by the standardization.

Stranding
Situation of users who had implemented a technology that failed to become the winning standard, which then consequently ceased to be supported or undergo further improvement.

Strategic standardization
Integration of several standardization products, services, processes, and subsystems to facilitate implementation of a complete system. These systems can then be implemented quickly and efficiently; examples: McDonald's and Microsoft Software (Betancourt and Walsh, 1995).

Strategy/strategies
This is a more long-term oriented concept involving not only the short-term tactics, but also a broader definition of the ways that have to be followed in order to achieve long-term objectives.

Substitute patents
These are patents offering alternative technologies within a given standard. Any such individual patent is not essential as there are substitutes available. However, a patent pool containing all substitute patents may lead to an anti-competitive situation.

Switching costs
These are costs incurred in changing (switching) from an established technology to a superior technology, which include the direct cost of purchasing the product with new technology as well as the indirect cost (opportunity cost) of learning how to use the new technology.

Tactics
The ways chosen by a company in order to pursue short-term goals. In external standardization they are used as part of enabling strategies to win a possible standards contest.

6 Key questions

- What enabling strategies other than 'Timing' and 'Form of cooperation' can companies use to win a standards contest?
- What factors are critical for a company to establish a unilateral de-facto standard?
- What kind of coalition can a company use in external standardization?
- How does a company decide on the positioning strategy prior to external standardization?
- What benefits can a market realize from external standardization?
- How can a company use standardization to its advantage?
- What would be the dangers of losing a standards contest?
- What are the key characteristics of formal standardization that assure fairness and equity among participants?
- How does a company (technology leader) planning to develop a standard, choose between international standardization and de-facto standardization?
- What benefits can a company realize from participating in formal standardization

Wilfried Hesser & Axel Czaya

Abstract

This teaching module outlines the strategic and economic potential of standardisation, especially with regard to globalised markets. It shows how standardisation can be applied by companies as a strategic instrument in competitive global environments. Among the issues discussed are network effects, network externalities and de facto standardisation.

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1 Introduction

Although standardisation is a technical issue by nature, it ultimately serves economic ends. It is even fair to say that the technical dimension of standardisation is only of secondary importance; instead, it is the economic benefits which provide the driving force behind virtually every standardisation activity. This is the reason why standardisation always has to be assessed from an economic point of view (Hesser, 1990a, 5).

Facilitated by significant advances in the field of information & communication technologies (ICT), globalisation nowadays assigns standardisation a role which goes far beyond traditional industrial rationalisation. Rather, and especially in hi-tech sectors, standardisation has become a powerful strategic variable which is not only a constituent part of markets but also generates billions in revenues (and profits) for which companies eagerly compete. In this respect, the dictum applies: 'He who owns the standard owns the market (Hesser, 1990a, 5).' This not only holds for the ICT sector but can easily be generalised: an adequate standardisation strategy is a prerequisite for companies in virtually all sectors and branches of industry if they are to seize the opportunities that accompany globalisation. This may be accomplished by in-company standardisation or by engaging in standardisation activities outside the company, and standardisation may be a strategic core asset or may provide an auxiliary function and support the core competences of a company. For this reason the economic potential of standardisation and the effects that the standardisation strategies of companies may have on society are outlined and discussed in this teaching module/chapter. Emphasis is placed on market structures and network attributes.

2 Classification of standards

Standards can be classified in a variety of ways, depending on the various perspectives and declared objectives. One may, for example, refer to the originator of a standard (i.e. the entity which produces and puts out a standard and the related standards-setting mechanism), the legal status of a standard or specific attributes of an object to classify standards. The following classification scheme based on originator/mechanism is especially useful:

- Competitive standards: These standards originate from the free play of market forces. Competitive standards usually bear the mark of leading enterprises or business consortia.

- Committee standards: Standards-setting committees are usually associations under private law, such as DIN or ISO. Committees rely on the consensus principle in standards preparation. The standards are prepared by various stakeholders and interested parties.
- Hierarchy standards: These standards are set by state authorities with sufficient legal powers or within hierarchical structures such as companies. Hierarchy standards are usually legally binding within their given domain.

Legally binding standards are frequently termed 'de jure standards' and voluntary standards 'de facto standards'. According to the attributes of objects or products being standardised, one may distinguish between:

- Environmental standards
- Safety standards
- Quality standards
- Variety-reducing standards
- Compatibility standards

2.1 Introduction

This section provides an overview of different types of standards and some background information on standards origination. A distinction is made between legally binding standards (standards set by an authority with adequate legal/regulative powers, de jure standards) and voluntary standards (standards created by private agents' interaction, de facto standards). The standards formation stage is particularly interesting from a strategic perspective because, at this stage, companies have a window of opportunity to shape a standard according to their preferences. The terms 'de facto standards' and 'de jure standards' are used extensively in this section, as well as the classification scheme based on originator/mechanism (competitive standards, committee standards, hierarchy standards). Throughout this teaching module compatibility standards will play a key role.

2.2 Basic terms in standardisation

A standard is a set of technical specifications to which companies adhere either voluntarily/tacitly or by virtue of a legal act and which always provides some form of unification. David (1987, Chapter 8) has introduced a widely applied categorisation of standards which is based on functionality and related economic effects:

- Compatibility standards (define interfaces and protocols, for example, and create systemic and economic interrelations),
- Information/measurement standards (define weights, measures, currencies, etc.),
- Minimum quality/safety standards (define product safety margins to protect consumers),
- Variety-reducing standards (provide cost reductions by reducing the number of different parts used in production and/or by slimming down the product range).

On the basis of David's scheme, Kleinemeyer (1997, 59) distinguishes between five categories of standards (see Figure 1):

- Ecological standards
- Safety standards
- Quality standards
- Variety-reducing standards
- Compatibility standards

Classification of standards according their economic effects

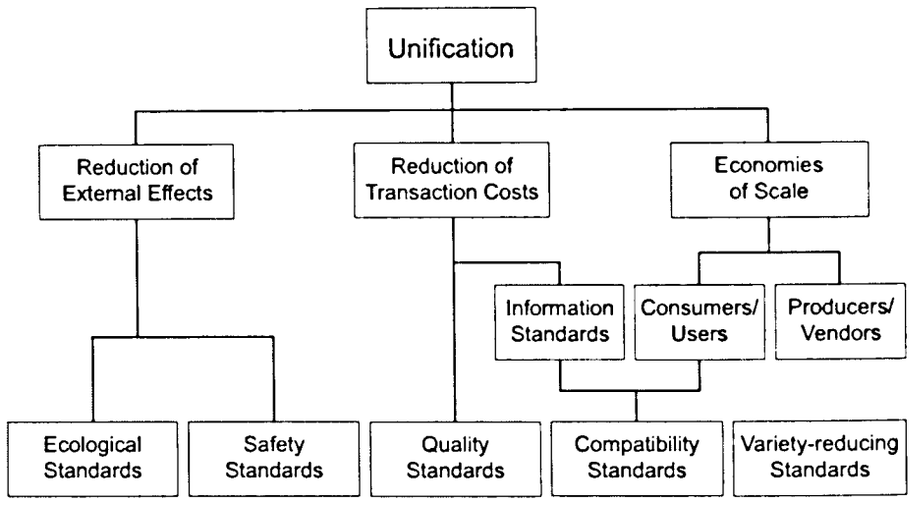


Figure: Classification of standards according to their economic effects (Source: Kleinmeyer, J. (1997), Standardisation between cooperation and competition. Peter Lang: Frankfurt a. M., 58)

David's and Kleinemeyer's categorisations hint at the benefits that accompany standardisation. For instance, meeting a quality standard implies that a given product fulfils certain (minimum) requirements laid down in the standard. As a result, the user/consumer is provided with a measure which allows him to compare and choose between different products (of a given product class) more easily. By signalling certain quality levels, quality standards obviously reduce transaction costs and alleviate information asymmetries between users/consumers and suppliers/producers (Foray, 1993, 84-101). Information asymmetries of this kind frequently occur when users/consumers cannot observe certain product attributes (or face high costs in doing so). In the extreme case, i.e. in a market where buyers cannot distinguish between different levels of quality, the low-quality goods drive out excessively high-quality goods (Akerlof's 'Market for Lemons'). Buyers only observe the average quality and are willing to pay a corresponding price, which is, however, lower than that for high-quality goods. The sellers of high-quality goods consequently face zero demand and move out of the market while the sellers of low-quality goods remain in the market (Akerlof, 1970, 488-500). Quality standards can obviously help to avoid such market dynamics (which depend on the precondition that it is sufficiently costly to imitate and send deceptive quality signals (Frank, 1987, 593-604).

Compatibility standards on the other hand enable certain products to interoperate in a broader systemic context. Such products may fit into a system as a component, module or subsystem and may stem from different producers/vendors as long as these adhere to the same set of compatibility standards. In this respect a precise specification of interfaces (input and output attributes of system elements) is pivotal for the overall functioning of the system. A common example for the benefits of compatibility is the hi-fi system: audiophiles can combine components of different manufacturers to build the system which exactly meets their demands. Furthermore, compatibility is a prerequisite for networks to operate (e.g. the telephone network) or the interoperability of a core product and its complementary goods (e.g. printers and ink cartridges).

Safety standards and environmental standards in the first place avoid or alleviate the negative external effects (see Section 5.4), which may emanate from certain products, (production) processes and activities and to which not only users, consumers and third parties but also the ecosystem in general may be exposed. In the case of environmental standards this may be accomplished by defining emission or concentration limits for noxious substances. Safety standards protect users, consumers or third parties from risks and hazards to health that emanate from specific products, (production) processes and activities.

Another classification scheme that proves popular, especially among economists, was introduced by David & Greenstein (1990, 4):

- Unsponsored standards: In this case, no distinguished originator exists that may hold any property rights in a standard. Unsponsored standards are usually created by market forces, nevertheless well-documented and readily available to the public.
- Sponsored standards: Some entity (e.g. an organisation, firm or consortium) holds property rights and has a commercial interest in a standard.
- Standards agreements: These standards are prepared by standards-setting bodies such as DIN, ISO or standards consortia and are open to the public.
- Mandated standards: These standards are imposed by state authorities and legally binding.

Sponsored and unsponsored standards emanate from market interaction. This (and the form such standards finally take) depends on consumer preferences and commercial interests of companies which in turn give rise to buying decisions and strategic corporate behaviour. Standards that result from market dynamics are called de facto standards and standards agreements and mandated standards de jure standards, although only mandated standards represent a legal act in the strict sense. A common feature of standards agreements and mandated standards is that they are the result of political opinion-forming and negotiation processes. This can but need not necessarily be influenced by market con-siderations.

On the basis of David & Greenstein's categorisation, Kleinemeyer (1997, 52) distinguishes between the following terms which are frequently used throughout this teaching module/chapter:

- Standard: Umbrella term for all forms of unification.
- Competitive standard: Such a standard is the winner of a standards battle in a given market between two (or more) specifications or technologies. The result of such a competition depends not only on the given attributes of the competing specifications/technologies, but also on the market actors' adoption patterns/adoption sequence and is therefore random to some degree.
- Committee standard: Committee standards are prepared in a deliberate effort by the interested parties (producers, vendors, consumers/users, NGOs and the like) in a committee. Standards committees have an organisational structure and standards preparation is carried out according to some given rules of procedure. Committee standards are easily available to the public; often for a fee and sometimes free of charge. Both acknowledged standards (as issued by acknowledged standards bodies like the DIN or ISO) and Technical Specifications or Publicly Available Specifications ('PAS', see e.g. Hesser (1997, 21), as prepared by standards consortia and fora) fall into this category.

- Hierarchical standard: Hierarchical standards are imposed by high-level decision making entities (e.g. the company management, a state authority or EU organs) and are legally binding.

Standards may also be classified according to their legal status. A core criterion is the degree to which a standard is legally binding. Basically, the use of standards is voluntary, i.e. there is no legal obligation to use/apply a standard. On the contrary, it tends to be the benefits derived that induce an agent to use/apply a standard or to engage in standardisation activities. In the case of de facto standardisation and given the existence of network effects, the decision rationale of a given agent takes the following course: given the fact that all other agents use (de facto) standard *X*, the optimal choice is to apply standard *X* as well - or put differently: it is not useful or may even be nonsensical to deviate from standard *X*, even if an agent wishes to do so. The second formulation points at the fact that a de facto standard - despite the absence of any hard-wired legal obligation to apply it - may very well impose a coercive momentum on the relevant agents. A Linux enthusiast, for example, will consider it a nuisance to be forced to use Microsoft XP or Vista (and the respective complementary goods such as Microsoft Office) for reasons of interoperability, because most of his business partners, colleagues and friends do so.

Standards may become legally binding in a variety of ways. Standards to which business partners refer in contracts (e.g. *'...we agree to deliver 10 tons of cement according to DIN EN 197...'*) become immediately binding on the level of contract law. Furthermore, legislators frequently need to refer to 'the state of technology', e.g. in product liability law. In such cases' (acknowledged) standards provide a useful measure (see below), are referred to in legal texts/laws or cited and thus become legally binding. In legislation there are different methods of referencing to standards:

- The text of a standard or elements thereof may be directly incorporated in a legal text.
- In the dated direct reference method the number of the standard, its title and date are quoted.
- In the undated direct reference method only the number and title of the standard are quoted. The advantage is that a legal text need not be modified as soon as a new version of a standard is published. The disadvantage is, however, that a legal text and the referred standard are not as stringently related as under the dated direct reference method and standards-setters gain some influence on the wording/purpose of a legal text.
- General reference to the 'state of the art' or 'acknowledged rules of technology'. No explicit reference to a standard is made in a legal text. Instead, general terms such as 'acknowledged rules of technology' are used and legal text and standards are linked ad hoc as soon a decision is prepared in a given case.

Finally, it is useful to distinguish between general and 'acknowledged standards'. An 'acknowledged standard' (in German and French 'norm') has been published by a standards body which adheres to a set of 'basic principles of standardisation' (see Figure), is (not least for this reason) recognised by state authorities (or supranational/international organisations with appropriate governmental powers such as the EU) as a partner in industrial/economic policy and granted a number of privileges, such as the right to be the sole representative of a national standardisation system on the level of international standardisation. The main difference between a standard as created by consortia or market forces and an acknowledged standard does not lie in the wording or content (which might even be identical), but in the institutional framework under which they are prepared. This institutional framework (especially the set of basic principles of standardisation) provides an acknowledged standard with a higher degree of legitimacy which is regarded by state authorities as a prerequisite for application in legislation or industrial/economic policy.

Basic Principles of Standardisation

- Voluntary basis: Nobody is compelled to take part in a standardization project. Equally, nobody is compelled to adopt a specific standard.
- Open book: All standards projects and draft standards are subject to public scrutiny. Especially those interested parties who did not participate in a specific project are encouraged to comment on it.
- Open door: Everybody who is interested in a specific standardization project is allowed to take part in it.
- Uniformity and consistency: Overall aim is to build and keep a consistent and integrated standards repository.
- Consensus: The consensus principle is the prevailing decision making mechanism.
- State of the art: The state of the art in science and technology shall be incorporated in standards.
- Primacy of public interest: Public interest shall prevail over individual interest.
- Global approach: The primacy of international standardization is acknowledged.

Figure: The basic principles of standardisation (Source: DIN (2001): Basic principles of DIN Standardisation. No 10, 7th Edition. Beuth Verlag: Berlin

3 Market forces and effects

In this section the most relevant market participants and attributes which a company faces are introduced, and some of the market strategies that companies frequently apply are discussed. A good starting point is provided by Porter (1990, 26), who distinguishes between a number of market forces and generic strategies. The most important market forces are:

- Competitive rivalry
- Bargaining power of customers
- Bargaining power of suppliers
- Threat of the entry of new competitors
- Threat of substitute products

Porter (1990) additionally introduces three generic strategies:
- Cost leadership strategy: A firm tries to exploit factors such as economies of scale or learning curve effects to produce at a lower cost per unit than its competitors. This opens up the scope for competitive price-setting.
- Differentiation strategy: A firm tries to set itself apart from its competitors, especially with unique product features.
- Focus strategy: A firm focuses on specific markets, market niches or products in or with which it performs exceptionally well.

These generic competitive strategies provide a reference point that is generally used in the subsequent discussion of strategy concepts and models, and also prove to be useful with regard to standardisation strategies. In the context of standardisation, the strategy of dominance (or dominant design) is also frequently discussed in the literature (see e.g. den Uijl & de Vries, 2008). This strategy aims at a superior design and/or the use of property rights, especially intellectual property rights (IPR), to build up market entry barriers or to become market leader.

3.1 Market forces and effects

In this section the dynamics are discussed which characterise the competition in a market and for a market. According to Porter (1990, 26) the most important market forces are:

- Competitive rivalry
- Bargaining power of customers
- Bargaining power of suppliers
- Threat of the entry of new competitors
- Threat of substitute products

The interaction between different market forces strongly depends on the behaviour of firms and the strategies they apply. Cost leadership, differentiation and focusing are strategies frequently applied by firms. In the given context of standardisation, the strategy of dominance is also widely pursued.

3.2 Economic entities

In a first step it is useful to understand which role different actors assume in the economy. A suitable starting point is provided by microeconomic theory in which households, firms and the state are distinguished. According to this theory, every entity behaves rationally. Rational behaviour appears in two different, dual guises which can, however, be traced back to one underlying economic principle:

- Given limited resources, households maximise their utility and firms maximise their profits.
- Households and firms spend only the minimum of resources necessary to reach given targets/target values.

According to microeconomic theory, economic entities perform an optimisation calculation which is subject to constraints. Households maximise their utility (by consuming goods) according to their set of constraints (especially their budgets), whereas firms use their production technologies to transform inputs into outputs to maximise profits (at given market prices). The state not only sets the institutional framework for economic activities by imposing laws, rules and regulations, but also procures goods and services. In detail, economic entities are subject to the following constraints:

- Time constraints
- Resource constraints
- Financial constraints
- Institutional constraints
- Conventions and socialisation

Both the consumption plans of households and the production plans of firms are coordinated by the market mechanism/price mechanism. In theory, the market system/price system is not only capable of balancing supply and demand on all markets in a given economy; but the respective state of the economy also meets welfare criteria such as the Pareto efficiency. A distinctive feature of a market system is competition. Competition imposes permanent pressure on companies to offer marketable products at competitive, i.e. sufficiently low, prices in order to produce cost-effectively and to preserve competitiveness with process innovations and product innovations. With regard to standardisation strategies, in particular, two forms of competition can be distinguished:

- Competition within a market: this situation has just been described above.
- Competition for a market: this occurs, for example, in the case of emerging markets, on which innovative technologies and products can be expected to compete for significant turnovers and profits. Consequently, firms have a strong strategic incentive to shape the basic attributes of such emerging markets according to their interests, e.g. to establish a de facto standard and dominate the whole market.

An often-quoted example for the last case is the market for microcomputers at the beginning of the nineteen eighties, when the IBM Standard PC and Microsoft DOS managed to gain almost complete dominance. The following Figure provides an overview of the forces that shape the competition in and for markets (Kleinemeyer, 1995, 2).

The relation between competitive forces, strategic targets and company standardisation

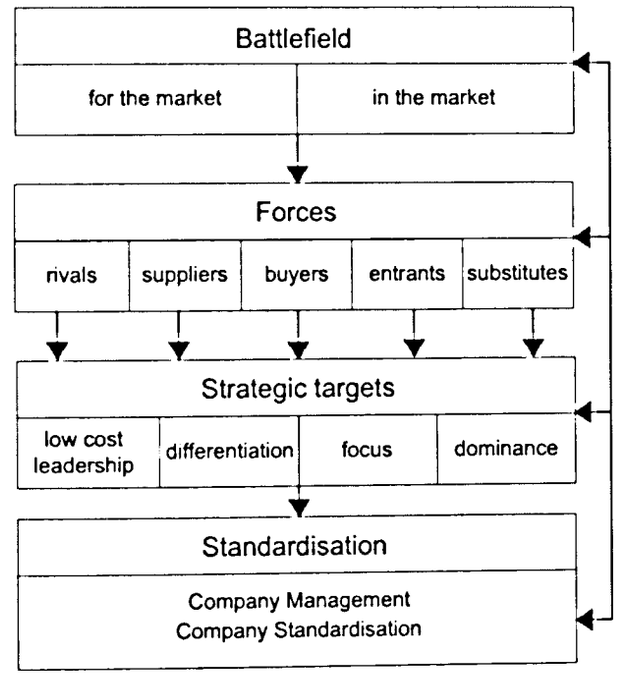


Figure: The relation between competitive forces, strategic targets and company standardisation (Source: Kleinemeyer, J. (1995): Standardisation as a Tool for the Strategic Management. In: Hesser, W. (ed.): Annual Report 1995 Universität der Bundeswehr Hamburg: Hamburg, 4).

3.3 Market forces according to Porter

As indicated in Section 2, the state of competition on a given market has significant repercussions on the profits companies earn. The harder the competition, the smaller the profit margins tend to be. Hence it is necessary for every firm to analyse the prevailing competitive forces on the markets in which it operates, and to align its strategies accordingly. Porter (1990, 26) identifies five main competitive forces:

Competitive rivalry
Rival firms impose pressure to produce efficiently and cost-effectively. This may include measures of rationalisation which is at the heart of standardisation. Under perfect competition in a given market, firms' profits tend to zero, as microeconomic theory predicts. Competition for a given market, however, opens up new opportunities for a company: Can market dominance be reached with one's own technology or should a firm team up with partners to do so? These strategic questions will be dealt with in Section 6.

Bargaining power of customers
The more bargaining power a customer has/the lesser the degree to which he depends on a specific firm, the narrower the scope becomes for price-setting above competitive prices. This holds both for competition in a given market and competition for a given market.

Bargaining power of suppliers
As in the case of powerful customers, suppliers can acquire and exercise considerable market power and may significantly reduce the profits of customer firms. Although a monopolistic supplier benefits from a broad scope of being able to dictate prices, the customer firms' market shares need not immediately be affected - as long as all firms face the same supply-side conditions. Furthermore, firms may escape the grip of monopolistic suppliers by the vertical integration of suppliers, i.e. by integrating preceding production stages into their own production process. Suppliers may also become competitors to a firm, e.g. by moving up the value-added chain and offering complementary goods (for instance ink cartridges for copiers).

Threat of the entry of new competitors
As soon as a potential rival overcomes market entry barriers, it becomes a direct competitor to an incumbent firm. In this respect it is useful to distinguish between structural market entry barriers and strategic market entry barriers. Structural market entry barriers are created by economies of scale for example, i.e. a newcomer may only be able to sell small quantities of a good at comparatively high unit costs or may be confronted with indivisibilities which prevent a newcomer firm from selling small quantities of its good. Strategic market entry barriers may exist in the form of excess capacities that an incumbent firm may threaten to use against potential rivals.

Threat of substitute products
Substitutes are products which can replace a given product to some degree or even in total (see e.g. Lowes & Pass & Sanderson, 1994, 182). The existence of substitutes introduces an upper price boundary for the product in question. As soon as the price of such a good exceeds the upper boundary, customers increasingly turn to substitutes. Substitutes can nevertheless be advantageous - as long as they impose a threat to rival firms in the first place. To defuse such a threat, a substitute may be horizontally integrated (i.e. its producer may be acquired by the firm in question).

3.4 Basic competitive strategies

In Section 3.3 introduced market forces, the determinants of competition, which not only set the framework for market interaction but also have a fundamental impact on companies' strategy choices. As already indicated, Porter (1980) distinguishes between the three generic strategies of cost leadership, differentiation and focusing:

- **Cost leadership:** A company aims to produce at a lower cost per unit than rival firms. This opens up scope to set prices lower than those of competing firms.
- **Differentiation:** A company aims to offer goods which are different/better than rivals' goods. This is achieved by superior product quality or superior product attributes which other comparable products do not feature.
- **Focus:** A company concentrates on a specific market/market niche where it performs exceptionally well.

As outlined before, it is useful with regard to the standardisation issue in hand to supplement Porter's generic strategies with a fourth strategy, namely dominance/dominant design (see e.g. den Uijl & de Vries, 2008). It should be noted, however, that dominance is not a generic strategy, as defined by Porter, but rather a hybrid strategy which combines elements of different (generic) strategies.

- **Dominance:** A superior design and/or exclusive property rights distinguish a product from rival products and may also impose market entry barriers. A dominant design may promote a firm to become market leader. The classic example is Microsoft which applied various (and sometimes dubious) strategies to build up a dominant position in the PC operating system and PC software markets.

Since its introduction, Porter's typology has been thoroughly discussed, criticised and supplemented/extended with additional strategies and typologies - last but not least by Porter himself (see e.g. Porter, 1985 and Section 3.4.3). Porter's typology nevertheless provides a point of reference in the literature on strategic management which - together with the strategy of dominance - is a good starting point with regard to the standardisation issue in hand. The present trends in management literature on competitive strategies will not be pursued in detail at this point, however. For some recent treatments of this issue see e.g. Haberberg & Rieple (2008) or Henry (2008) who gives Porter's approach due attention.

3.4.1 Cost leadership

Cost leadership puts a firm in a position to set low prices and/or fend off aggressive price-setting policies by rival firms. When entering a market, newcomers can usually produce and sell only small amounts of their goods. Consequently, economies of scale cannot be exploited, resulting in comparatively high unit costs and high (cost-effective) prices per unit. Cost leadership obviously works as a market entry barrier and provides the cost leader with a monopoly in the extreme case.

However, the strategy of cost leadership also comes with risks. Cost leadership often involves highly specific and irreversible investments in a highly specific production system. Once locked in and lacking sufficient flexibility, a cost leader runs the risk of being sidelined by technological leapfrogging, historical events or changes in the general circumstances, e.g. in the legal framework.

As indicated before, standardisation has played a pivotal role in industrialisation, (still) is a powerful instrument of rationalisation and cost reduction and therefore immediately supports cost leadership strategies. Cost leadership strategies are frequently applied in industries where mass production, e.g. in the form of flow production, is common, where products are homogenous to a large degree, and where specific and irreversible investments in a specific and complex production system are made. This is the case in the steel or cement industry for example.

3.4.2 Differentiation strategy

By differentiation a firm distinguishes itself from rival firms with special if not unique product attributes. This enables a firm to win a specific, loyal clientele and to set prices above the market average. Differentiation often implies some degree of exclusivity and is usually accompanied by small market shares. Differentiation strategies can often be found in the luxury goods segment

where individual skills, handiwork, elaborate techniques and customisation, i.e. costly and non-standardised production methods, prevail. Therefore, differentiation strategies seem to offer only a limited scope for the instrument of standardisation at first glance, which is indeed true in many cases. In some cases, however, the challenge is to 'square the circle', i.e. to apply the instruments of standardisation without compromising the goal of differentiation. Common examples of this are the platform strategies that car manufacturers such as Volkswagen pursue. The basic idea behind platform strategies is to standardise only those elements of a product, such as the chassis or range of engines, that do not have an impact on those elements which are suitable for differentiation, such as the car body, the interior or the design as such. As a result, different customer groups can be approached with a product that is both standardised and customised at the same time.

3.4.3 Focus strategy

By applying a focus strategy, a firm concentrates its activities on a specific niche, e.g. a certain product, range of products, production process or customer group, and thus gains a competitive advantage (Formby & Thompson, 1993, 428). To what extend a focus strategy can be supported by the instruments of standardisation depends on the given situation. For instance, a successful focus strategy may crucially depend on an all-encompassing standardisation approach to a given product or production process or on a market-based standardisation approach ('de facto standardisation'). On the other hand, a focus may also rely on a unique feature such as an idiosyncratic production process, i.e. non-standardisation' in the broadest sense. Giving up business areas that are not part of a firm's core business can also be regarded as a focus strategy. Porter, by the way, at first assumed that the generic strategies of cost leadership, differentiation and focus are mutually exclusive but later adopted the stance that cost leadership and differentiation can be combined with a modified focus strategy and a focus may take two different forms, namely wide focus (large market share) or narrow focus (small market share; see Porter, 1985).

3.4.4 Dominance

Dominance is based on a technological, structural or legal advantages that a company has over its rivals (see Lee et al., 1995, p. 3-15 and den Uijl & de Vries, 2008). The dominance of a firm need not necessarily depend on the factual superiority of its product but may also be the result of clever marketing, historical events, the legal framework or network effects which feature prominently in the context of standardisation (see Section 4.3). Of course, property rights such as patents and copyrights are powerful instruments for gaining and

preserving a dominant market position. The purpose of such legal instruments is to hamper the market entry of possible rivals.
Firms often compete fiercely for dominance because a dominant market position opens up the perspective of a monopoly. Indeed, firms run the risk of losing the fight for the dominant design, the de facto standard, as there is usually only one winner. The losers of a battle for dominance incur the costs of their sunken investments (and no returns) and may even be forced to exit the market.
Factors such as design, marketing, the legal framework, historical events, determine not only the success of one firm but also the failure of its rivals. However, there is no room for complacency for a dominant firm, as it may easily lose its favourable position, e.g. because of technological quantum leaps, significant changes in the legal framework or intervention by a regulatory agency, such as the Federal Trade Commission or the 'Bundeskartellamt' in Germany. For instance, the European Court of Justice imposed a number of substantial fines on Microsoft for anticompetitive behaviour (see e.g. BBC World News, 2004).

4 Standardisation and specific market structures

This section discusses the market structures and attributes that favour the emergence of a dominant design or a de facto standard. Emphasis will be placed on networks and corresponding phenomena such as network externalities.
Networks are based on the compatibility of technical systems and create positive externalities by enabling/facilitating the cost-effective exchange of goods, services, energy and information. Positive network externalities, as is usually assumed in textbooks, depend on the size of the network: the bigger the network, i.e. the higher the number of networked, interlinked agents, the higher the utility a single agent derives from the network. Below, different forms of compatibility are discussed, namely horizontal compatibility, complementarity, indirect horizontal compatibility and backward compatibility.

4.1 Standardisation and specific market structures

The following discusses the different forms of compatibility as well as the phenomena and market structures which are generated by networks.

4.1.1 Compatibility and complementarity.

As already indicated, compatibility enables technical systems and/or agents to exchange matter, signals and energy. In this respect the decisions that firms make on the compatibility (or incompatibility) of their systems and products with other systems and products often have far-reaching strategic implications. Decisions of this kind not only determine basic product attributes and systemic interrelationships, but also shape specific market characteristics, such as the basic position in which competing firms find themselves, the intensity of competition, or market growth. For instance, firms with a weak market position may establish compatibility with the market leader's products/systems in order to snatch away some of its market share (see Section 6.2.4). A precondition for such a strategic move is that the market leader's interface specifications are available to the rival firm (or the public in general), either for free or at reasonable costs, e.g. in the form of licences, or that some kind of workaround can be established, e.g. in the form of an adaptor or emulator. The following sections address different forms of compatibility according to Wiese (1997, 283).

4.1.2 Horizontal compatibility

Functionally equivalent products which are interconnected to exchange matter, signals and/or energy are said to be horizontally compatible (see Figure 4 for an illustration of direct horizontal compatibility). Horizontal compatibility is a prominent feature of communication networks, e.g. the telephone network (see e.g. Farrell & Saloner, 1987, 2). Telephones (of different vendors) are functionally equivalent, identical with regard to their interfaces, interconnected via the network infrastructure and occupy the same hierarchical level. Furthermore, a distinction is made between direct and indirect horizontal compatibility (see Section 4.2.3). Direct horizontal compatibility is also called 'single good compatibility' and standards which create direct horizontal compatibility 'peer-to-peer standards' (see Sirbu & Stewart 1985, 2).

Direct horizontal compatibility between functionally equivalent products

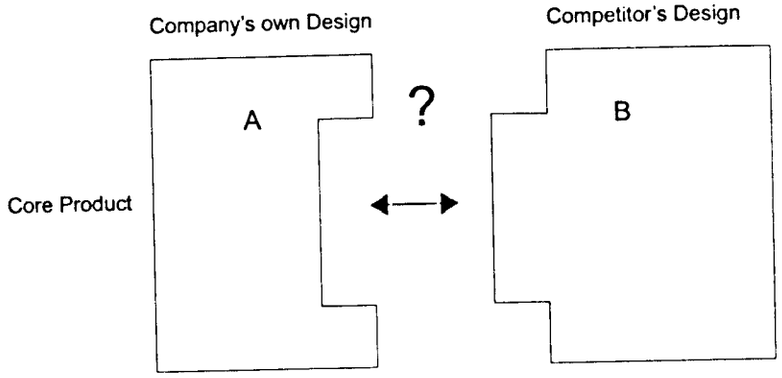


Figure: Direct horizontal compatibility between functionally equivalent products (Source: Wiese, H. (1997): Compatibility, Business Strategy and Market Structure - a Selective Survey. In: Holler, M. J. & Niskanen, E. (eds.): EURAS Yearbook of Standardisation Vol.1, Accedo: Munich, 287).

4.1.3 Vertical compatibility/complementarity

Functionally different products which are interconnected to exchange matter, signals and/or energy are said to be vertically compatible. Vertical compatibility exists between vertically interrelated products, the core product and one or more complements - which is why vertical compatibility is also called complementarity. The combination of core product and complements is called a bundle (See Figure 5 where 'c' denotes the complement).
Typical examples of complementary products are computer hardware and software, CD players and CDs, video recorders and video cassettes, trains and rails, cameras and lenses, etc. However, not all core products and complements are compatible. Rail gauges, for instance, may vary between different countries, with the result that the wheel sets of trains crossing the border may have to be refitted or adjusted (Kindleberger 1983, 377-396). Complementarity usually implies a vertical hierarchy of some sort - in contrast to horizontal compatibility, where two products/network elements occupy the same hierarchical level (see Sirbu & Stewart 1985, 2).
The case of 'dynamic complementarity' exists when a core product is compatible with old and/or forthcoming versions of a complement, although these complements have been or will be basically designed to interoperate with other core products/platforms. Compatibility with old versions is called 'backward compatibility' and compatibility with future versions 'forward compatibility'.

The decisions that firms as well as consumers and users make with regard to backward or forward compatibility can have far-reaching consequences. As soon as a core product is not backward compatible anymore, older versions of a complementary good immediately become obsolete. For example, as soon as consumers buy a CD player and dispose of their record player, their record collection immediately becomes obsolete because records cannot be played on a CD player. DVD players, however, can read CDs, the preceding generation of storage media, and are therefore backward compatible.

Vertical compatibility

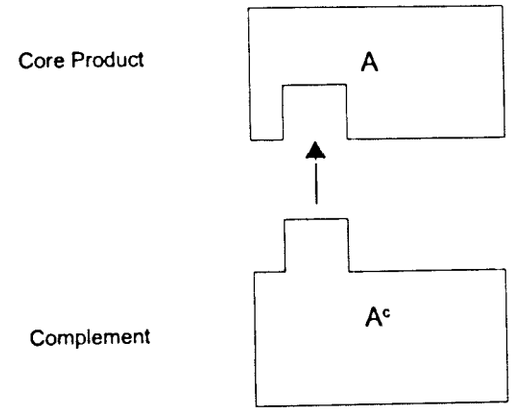


Figure: Vertical compatibility (Source: Wiese, H. (1997): Compatibility, Business Strategy and Market Structure - a Selective Survey. In: Holler, M. J. & Niskanen, E. (eds.): EURAS Yearbook of Standardisation Vol.1, Accedo: Munich, 287).

4.1.4 Indirect horizontal compatibility

Compatibility can also be indirectly established by workarounds: indirect horizontal compatibility applies when the complements of a firm's core product are also compatible with another, different core product. In the following Figure, Product A is indirectly compatible with B, because BC, the complement to B, is also compatible with A. In this case, single-sided compatibility exists, because AC and B are not compatible.
With the support of the boot manager Boot Camp, Windows XP/Vista and Windows applications can be installed and run on more recent Apple computers. As PCs and Windows XP/Vista do not provide any comparable feature to install and run Apple software, single-sided compatibility exists in this case. It should

be noted, however, that Apple had to switch from PowerPC architecture to Standard PC architecture in 2006 and thus made a significant step towards the PC standard in terms of hardware. Furthermore, indirect horizontal compatibility can often only be achieved to some degree, because emulators and virtual machines reduce their platforms' performance and often fail to execute software correctly.

Compatibility not only links up technical systems but also the corresponding markets. These market interrelations can be described with tools that economic theory provides. The cross elasticity of demand, for example,

$$\eta_{A,B} = \frac{dx_A}{dp_B} \cdot \frac{p_B}{x_A}$$

measures the percentage change in demand for good A that results from a percentage change in the price of another good B. If A and B are complementary goods and the price of good A increases, then $\eta_{A,B}$ turns out to be negative.

Indirect horizontal compatibility

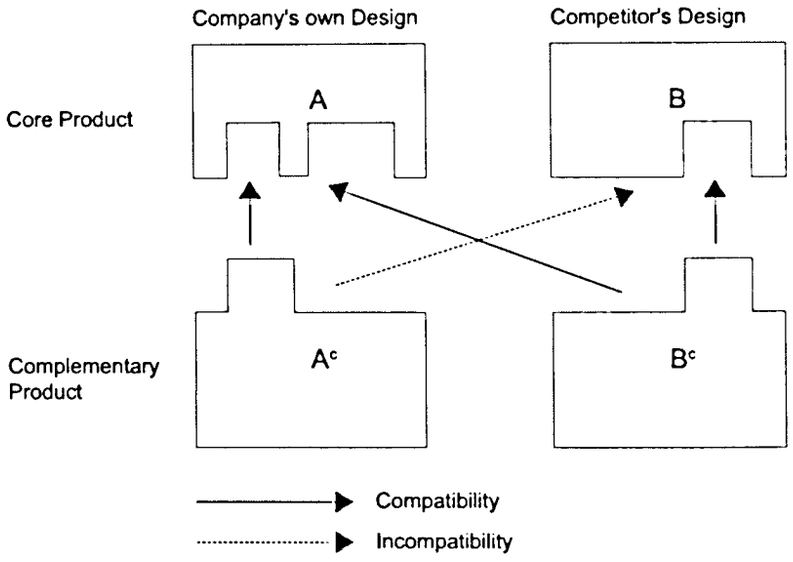


Figure: Indirect horizontal compatibility (Source: Wiese, H. (1997): Compatibility, Business Strategy and Market Structure - a Selective Survey. In: Holler, M. J. & Niskanen, E. (eds.): EURAS Yearbook of Standardisation Vol.1, Accedo: Munich, 287.

The reason for this is that price-induced changes in demand for core product and complement are positively correlated because both goods exhibit the characteristics of a bundle. If goods A and B are substitutes and the price for B increases then demand for A also increases ($\eta_{A,B} > 0$).

4.2 Network effects

(Horizontal) Compatibility, as mentioned above, facilitates the formation of (peer-to-peer) networks and the generation of network effects. Direct horizontal compatibility creates direct network effects and, accordingly, indirect horizontal compatibility creates indirect network effects. (Positive) Network effects have an immediate positive impact on the utility of individual users. In many economic models linear utility functions of the following form are frequently applied to deal with issues such as network effects or de facto standardisation:

$$u_i = v_i + a_i \tilde{N}$$

The 'network utility' v_i of agent i is specified as the sum of a network-independent term, v_i ('stand-alone-value'), and a network-dependent term, $a_i \tilde{N}$. v_i can take negative or positive values and if $v_i = 0$, then a pure network good exists. $\tilde{N}$ denotes the number of network participants in a society of size N ($\tilde{N} \leq N$). Usually, $a_i > 0$ is assumed, and, given this assumption holds for all agents i, each v_i is maximised, if the network size is maximised ($\tilde{N} = N$).
Section 6.3.1.1 introduces a model by Arthur (1989) on historical events and lock-in effects which nicely illustrates how linear network utility functions of the above kind are applied in economic theory.
The inherent dynamics of (positive) network effects can readily be deduced from the above thoughts, and these dynamics lead towards a maximisation of network size. The telephone network reaches its final destiny as soon as every household owns a telephone and has access to the network so that everybody can communicate with everybody else. At the same time it becomes evident, why firms fight fiercely in the presence of network effects to establish their own specifications as de facto standards: the victorious firm has bright prospects of being able to dominate the whole network and the whole corresponding market.
Although the literature primarily addresses positive network effects, this is an opportune point to take a brief look at negative network effects as well ($\alpha_i < 0$). Negative network effects may occur as soon as networks reach their capacity limits. The denser the road traffic, the longer it tends to take for a car driver to go from A to B, and the more users access an Internet resource, the lower the data transfer rate tends to be. Another example of negative network effects is provided by vaccines the effectiveness of which on the individual may depend inversely on the total number of vaccinations: the higher the number of

vaccinations, the higher the probability that a pathogen may build up resistance. However, extensive vaccination programmes can usually be expected to exert positive network effects (Röver 1996, 14-32).

4.3 Structural relationships in markets with network effects

The structures and interrelations on markets with core products and complements can become very complex. To address this issue, Wiese (1997, 290) considers a number of competitive situations where one or two firms (monopolistic, duopolistic situations) sell a single product (categories A and C), a bundle or a dynamic bundle (categories B and D, see Figure). Functionally equivalent products are represented by dots on equal levels and spectra of complements by horizontal lines. Interrelations between core products and complements are represented by lines; vertical lines represent firms' bundles, dotted lines the products of different firms and staggered lines represent the case of dynamic complementarity (B2 and D4-D6).

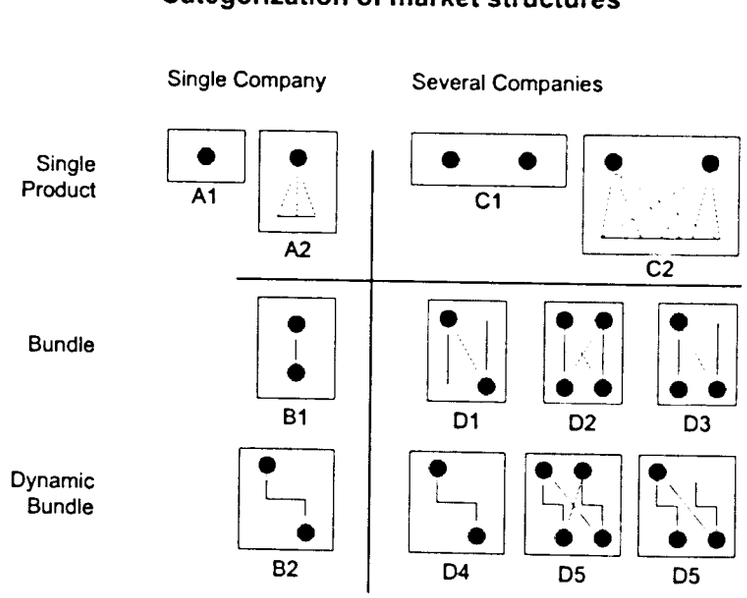


Figure: Categorisation of market structures (Source: Wiese, H. (1997): Compatibility, Business Strategy and Market Structure - a Selective Survey. In: Holler, M. J. & Niskanen, E. (eds.): EURAS Yearbook of Standardization Vol.1, Accedo: Munich, 290).

A1: A (possibly monopolistic) firm sells its product as a bundle, hence there is no differentiation into core product and complement. Such a situation may be the result of positive direct network effects, as shown in Section 4.2. Consider for instance a national telecom monopolist who exerts total control over the network, services, tariffs and terminal equipment.

A2: A firm holds a monopoly on a core product while other firms sell complements and compete on that level. For instance, a state monopolist may own and operate a telephone network while private firms offer tariffs and services and sell terminal equipment, etc.

B1: In this 'bundle situation', a monopolist not only sells a core product but also complements. A typical case is Microsoft which offers both the operating systems and the complementary software such as MS Office.

B2: The dynamic version of case B1. Users acquire core products and complements with backward and upward compatibility from a monopolist at different points in time. Different versions of complementary software (e.g. MS Office) are usually downward compatible (and upward compatible only to a limited degree).

C1: There is no interoperability between the products of two competing firms; compatibility only exists within the product range of one firm. Consider, for example, printers where ink cartridge and interface design is usually proprietary and idiosyncratic, i.e. non-interoperable.

C2: The core products of two firms are horizontally incompatible while the complements of various firms compete. This situation is typical for game consoles. A game developed for console *X* cannot usually be run on console *Y* and many games are exclusively developed for one console.

D1: One firm produces the core product and another firm the complement of a bundle. In terms of Section 4.2.3, both firms are synchronised with regard to market dynamics. Such is the case with the manufacturers of PC motherboards and memory chips for example.

D2: Both firms produce both core products and complements and are mutually compatible. For instance, hi-fi components from different manufacturers are compatible in most cases.

D3: One firm produces the complete bundle while another firm only produces a complement. Apple, for example, delivers a whole bundle of hardware and software while other firms only develop software for the Apple platform.

D4: Dynamic variant of case B1. A firms offer complements which are downward (upward) compatible to older (new) versions of another firms' core product.

D5: Dynamic variant of case D2; interpretation analogous to D4.

D6: Dynamic variant of case D3; interpretation analogous to D4.

5 Economic benefits of standardisation

After the preceding section addressed the interrelationships between compatibility, network structures and market, the next will take a closer look at the economic effects of standardisation which had been mentioned before in passing. As was stated, standards

- reduce transaction costs,
- are powerful instruments of rationalisation and open up economies of scale, and
- reduce externalities.

This section examines in detail how these effects come about. It also explores how standards can be applied in signalling and in the reduction/creation of barriers to trade and which role 'adoption costs' and 'switching costs' play in the choice of standards.

5.1 Economic benefits of standardisation

Both manufacturers and users/consumers benefit from standardisation in a variety of ways. To illustrate this point, different standards may be located in a 'triangle of economic effects of standardisation' where transaction costs, rationalisation/economies of scale and externality reduction each occupy one corner. With regard to firms and industry, standardisation has always been and still is a powerful instrument of rationalisation. In-company standardisation mainly aims to reduce variety, which in turn opens up the scope for increased productivity and cost reductions. This is the result of reduced complexity in production and better plant utilisation, e.g. in the form of extended machine times/shorter changeover times, increased batch sizes and easier/more cost-effective warehousing (see e.g. Hesser 1990b, 8).

5.2 Reduction of transaction costs

Transaction costs are costs which accompany economic exchange. Transaction partners who have implicitly or explicitly entered a contract firstly face search and information costs, secondly bargaining costs and costs of contract design, and thirdly policing and enforcement costs. Transaction costs, which Arrow (1969, 2) calls the 'cost of running the economic system', may reach significant levels, impede or even foreclose transactions that transaction partners basically regard as mutually beneficial and welfare-enhancing and may have significant repercussions on economic interaction and the economic system as

such. For Coase (1937), transaction costs constitute the main reason why firms exist. Firms internalise those transactions which the market system cannot perform at sufficiently low transaction costs (Kleinemeyer 1997, 62). Therefore the reduction of transaction costs - which significantly impede or forestall the beneficial/welfare-enhancing exchange of goods and services - is the main objective of many economic, structural or industrial policies. In this respect, standardisation plays a key role, as will be shown in the following sections. The reader may consider the Internet, which is constituted by a whole bundle of standards and which has significantly contributed to the reduction of transaction costs, especially search and information costs. Ebay, for instance, brings together transaction partners on a global scale who would otherwise never have come into contact (prohibitively high search and information costs).

5.2.1 Communication standards

Prospective transaction partners frequently face a number of communication problems. For example, in the search phase the challenge is to find each other and to communicate the willingness to enter into a transaction. In the bargaining phase a common code, a common language is needed to negotiate and design a contract. Apart from language in the stricter sense of the term (which already constitutes a standard, a common specification), a common set of technical terms and technical standards is indispensable in order to successfully design a contract. Such a set of standards requires basic and self-evident contents such as a standard time or common measures so as to avoid misunderstandings or wrong contractual specifications. A continental European who is used to metric standards such as the metre or kilogram usually has serious problems in dealing with Anglo-American weights and measures such as ounce, barrel, hogshead, bushel, inch, grain. These problems are aggravated by the fact that British and American weights and measures with the same name may actually differ. For instance, 1 British (Imperial) gallon equals 4.5459 litres, while 1 US gallon equals 3.7853 litres. It is more than evident from these considerations that without a sufficient set of common standards, significant mistakes or even a complete 'communication breakdown' may occur in transactions.

5.2.2 Signalling

Standards not only enable communication between potential transaction partners, but also carry information about certain product attributes and thus alleviate or eliminate information asymmetries between vendors/producers and customers/users. Consumers who face both uncertainty about specific product attributes or qualities and high information costs may eventually refrain from buying the good in question. In the worst case, information asymmetries lead to

an 'Akerlof equilibrium' (see Section 2.2) where only low-quality goods survive while high-quality goods are driven out of the market. To survive under these circumstances, sellers of high quality goods need to send unanimous quality signals to their target group. This may encompass not only appropriate advertising strategies and the creation of a high-quality image (Nelson 1974, 729-754), but also conformity to relevant quality or safety standards (David & Steinmueller 1993, 7). Ship-owners, for example, approach classification societies such as Lloyd's Register of Shipping to certify their fleet in accordance with Standards such as ISO 28000 (supply chain security management systems), ISO 14064 (greenhouse gases) or the Codes of International Maritime Organisation (IMO), which include the International Ship and Port Facility Security (ISPS), or the Code of the International Convention for the Safety of Life at Sea (SOLAS). Through these measures, a ship-owner signals to potential customers that his transport fleet meets internationally acknowledged ecological, safety and quality standards.

According to the basic principles of standardisation, the use of standards is usually voluntary. But as soon as public interest is affected, e.g. in the domain of occupational safety and health or consumer safety, standards may occasionally become legally binding. A good that fails to meet such standards, which often occur in the form of minimum standards, may be downgraded to a lower quality category or may even be forced out of the market. Thus standards-based quality signals are not always sent on a voluntary basis and in extreme cases, quality and safety standards may also serve as a barrier to market entry (see Frank, 1987, 593-604 and Anton & Yao, 1995, 261).

The actual signal which indicates conformity to one or more standards usually emanates from a mark of conformity, such as the CE mark of the European Union, and a certificate, both of which are the result of a conformity assessment procedure. It should be noted, however, that standardisation on the one hand and conformity assessment on the other are deeply intertwined: Even the best standards repository is worthless if it is not supplemented by effective instruments and institutions to assess whether a product actually meets the relevant standards. In turn, every system of conformity assessment is crucially dependent on a standards repository which provides the appropriate measures for certification.

5.2.3 Barriers to trade

With regard to the free trade of goods and services, standards prove to be a double-edged sword. On the one hand, regional and international standards have made a significant contribution to the reduction of regional and international barriers to trade, to the integration of regional markets such as the European Common Market or the North American Free Trading Area (NAFTA), and to globalisation as a whole. On the other hand, as the European experience shows in particular, diverging national standards repositories can

impose significant barriers to trade and may severely hamper efforts to integrate supranational economic areas. Diverging national standards may nevertheless be the result of national differences of various kinds and different yet legitimate public interests (especially with regard to quality, safety, consumer protection and environmental protection) and may thus impose unintended technical barriers to trade. In many cases, however, standards are used as a protectionist instrument, dedicated to protecting domestic firms from foreign competitors (Kleinemeyer 1997, 65).

A dramatic and entertaining example is intended to illustrate how standards can be used as a protectionist instrument (Kleinemeyer 1997, 29). When US sporting goods manufacturers tried to enter the Japanese market, they were surprised to learn that their baseball bats did not meet Japanese standards and thus were not permitted on the market. This annoyed the US side, and one businessman reacted as follows: 'In disgust, he ordered them [the bats] to be dumped into the ocean off the Japanese coast and they floated ashore - not the way most firms would like to see their products entering the Japanese market (Lecraw, 1987, 45).'

Basic Elements of the New Approach

- Political domain and standardisation domain are clearly separated.
- Regulatory intervention by EC organs is limited to the definition of essential requirements when public interest is affected.
- Public interest is given in the fields of quality, safety, consumer protection and environmental protection.
- Essential requirements are laid down in European directives.
- The elaboration of technical specifications, i.e. standards which are based on Essential Requirements, is handed over to European Standards Bodies. European Standards Bodies draw up 'Harmonization Documents' or 'Harmonized Standards' which have to be implemented on the national level. Simultaneously, contradicting national standards have to be withdrawn.
- Whenever European Standards are applied and indicated by applying the CE Mark, conformity with the Essential Requirements can be assumed and the respective goods are allowed to move freely in the EC ('presumption of conformity').

Figure: Basic elements of the New Approach (Source: Council of the European Communities (1985). Resolution of 7 May 1985 on a new approach to technical harmonisation and standards (85/C 136/01)).

The European experience also underlines how ambivalent the effects of standardisation can be if used as an instrument of supranational economic integration. Basically, the European standardisation policy, which is largely synonymous with the so-called 'New Approach' (see Figure above), aims to reduce technical barriers to trade by harmonising national standards repositories (see e.g. Hildebrandt 1995, 1).

Harmonisation within the EU, it is argued by some pundits, inevitably builds up external barriers to entry for non-member states. This criticism holds a fortiori because EU directives demand high levels of protection in those fields where regulatory intervention takes place, i.e. in the domains of quality, safety, consumer protection and environmental protection (see especially the Council Resolution of 7 May 1985 on a new approach to technical harmonisation and standards (Official Journal C 136, 04/06/1985), where the basic features of the New Approach are laid down). These high levels of protection, which EU organs call for, impose additional barriers to entry - especially for developing countries (Hesser 1990b, 5). Although this notion has been validated empirically to some degree (see e.g. Maskus & Otsuki & Wilson, 2005), a unified European standards repository can nevertheless be advantageous not only to European firms but also to non-European firms. In order to be allowed to market their goods in the whole European Economic Area (EEA), both European and non-European firms need to adapt their products to European Standards/directives and go through the conformity assessment procedure only once. Without a harmonised European standards repository, conformity assessment procedures and adaptation of a product to (national) standards and regulations would have to be carried out for every single European country - i.e. no less than 27 times in the extreme case (given 27 EU member states). In this respect a highly integrated European Common Market (by means of a harmonised European standards repository) proves beneficial not only for firms from the EEA, but also for non-European firms seeking access to the EU.

5.3 Standardisation and increasing returns to scale

In economic theory increasing returns to scale denote the phenomenon in production that an increase in input of, say, 1% leads to an output increase of higher than 1%. This phenomenon is correlated with decreasing unit costs because one additional output incurs fewer costs than the output unit produced beforehand. This implies that the quotient of total production cost and total output (which actually defines unit costs) decreases. The following sections show how standardisation generates increasing returns to scale in production, creates network effects on the demand side, and contributes to the reduction of negative externalities.

5.3.1 Standardisation in production

The main effect of standardisation in production is a reduction in variety (see e.g. Englmann 1989, 155). Standardisation methods such as size ranges, modularisation or platform concepts thus allow a reduced product range, more frequent use of repeat parts, larger batches, economies of scale in procurement, e.g. in the form of discounts, simplified and cost-effective warehousing, longer machine operating times/shorter changeover times and better overall plant utilisation. Standardisation of processes also provides scope to benefit from experience curves/learning curves (see e.g. Klock & Sabel & Schuhmann, 1987, 3-51). Meyer (1995) has shown in his research that firms' warehouses face an undesirable growth in the number of different parts and spare parts which will sooner or later have a detrimental effect on production processes. Prominent originators of such an unsolicited growth in parts are the sales and marketing departments and their pronounced customer focus, which leads to a high number of product variants. Furthermore, design engineers tend to 'reinvent the wheel', i.e. to design parts from scratch over and over again - instead of using repeat parts or standardised parts. As a consequence, economies of scale cannot be exploited due to smaller batches, longer changeover times, etc. and warehousing and construction/design management become increasingly complex. In this respect (in-company) standardisation can make a valuable contribution to the reduction of complexity in production processes, which tends to increase without appropriate countermeasures. Thus, in-company standardisation, having gone slightly out of fashion in the literature recently, has regained some eminence in the context of complexity management (see e.g. Schuh & Schwenk, 2001).

Reduction of variety also brings costs (or more precisely: costs and profit cuts), as the following considerations will show. To maximise the benefits standardisation can generate, variety needs to be minimised, i.e. a single and highly standardised production process is applied to produce one (and only one) product which largely consists of standardised parts. However, such an extreme approach will rarely be in the interest of a firm, because only a very small costumer segment can be served with such a highly standardised product and some possibly large profits will certainly be sacrificed. Hence, some degree of product variety to address a broader customer base will in most cases be in the economic interest of a firm. Similarly, the other extreme of maximising product variety by customising each product for every possible customer will rarely be economical either. In the latter production scheme, the costs of variety and complexity are maximised thus exceeding the revenues. For firms there is obviously a trade-off between product variety on the one hand and standardisation on the other, and the challenge is to strike an optimal balance between these two extremes or to standardise in such a fashion that product variety is only compromised to a small degree, if at all. Squaring the circle in such a fashion comes under the name of 'mass customisation' and may include the above-mentioned size-range, modularisation and platform concepts. A prominent example of mass

customisation is the Swatch watch which can be easily refitted to meet customer demands or take into account the latest trends (see Müller, 2008, 66).

Faced with a highly standardised and hence reduced product range, customers can choose from only a small number of variants which can hardly be expected to meet their demands exactly. Given the preferences of an arbitrary customer, a highly standardised product can usually be expected to over-perform in some respects and under-perform in others. The 'distance' between customer preferences and actual product attributes invokes costs which may take the form of 'adoption costs', i.e. the costs customer incur by tweaking a product to match their actual preferences (Bongers 1990, 11). If the distance between preferences and product attributes and the incurred adoption cost is sufficiently large, a customer will refrain from buying the given product.
These interrelations can be nicely illustrated in a 'Hotelling model' (see Figure).

Adaption costs and diverging preferences: the case of one standard

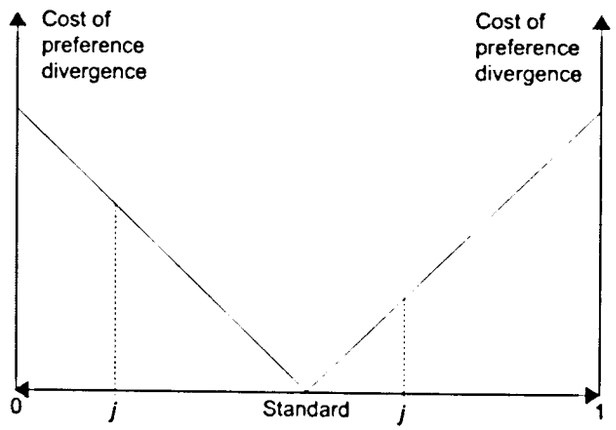


Figure: Adoption costs and diverging preferences: the case of one standard (Source: Kleinemeyer, J. (1997): Standardisierung zwischen Kooperation und Wettbewerb. Peter Lang: Frankfurt a.M., 72).

Consider a good with one attribute which can be mapped on a [0,1]-interval. Such a good might be a chemical compound, e.g. a drug, and the attribute the percentage purity in which it is marketed. This good is offered in a standard size and the greater the distance between the standard size and a customer's preferences, the greater the incurred adoption costs. In the figure above, these costs are assumed to be linear (which need not necessarily be the case) and

become zero only if standard size and consumer preference coincide. Customers will refrain from buying the standardised product as soon as the sum of purchase price and adoption costs is higher than their willingness to pay. If one assumes uniform distribution of customers over the [0,1]-interval and every customer buys the standardised product, then the social costs of adoption are given by the areas underneath the cost functions in the figure above. By introducing two standard sizes, as depicted in the following figure, the social costs of adoption can be reduced (the area under the cost functions is obviously smaller than in the one-standard case). Customers are now affected differently, however. For instance, the customer segment in the middle of the [0,1]-interval now faces significantly higher adoption costs than before, while the customers at both ends of the interval enjoy significant cost reductions. The more standard sizes are introduced, the smaller, obviously, the social costs of adoption, which, however, is offset by higher costs of variety and complexity on the part of the firms. A firm which serves such a market will operate at its optimal (i.e. profit-maximising) degree of variety which will usually not coincide with the state of zero social costs of adoption.

Adaption costs and diverging preferences: the case of two standards

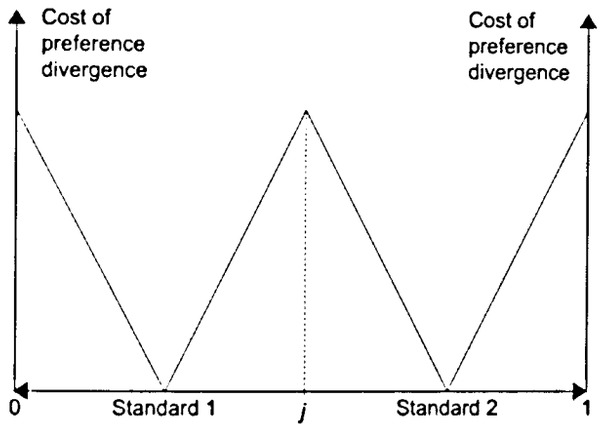


Figure: Adoption costs and diverging preferences: the case of two standards (Source: Kleinemeyer, J. (1997): Standardisierung zwischen Kooperation und Wettbewerb. Peter Lang: Frankfurt a.M., 72).

5.3.2 Economic consequences of standardisation and network effects

In Section 4.3 it was shown that network effects induce a demand-driven thrust towards the maximisation of network size. These demand-side dynamics favour the creation of monopolies on the supply side. With the exception of natural monopolies or so-called 'contestable markets', this is usually regarded as problematic from the economic point of view, because monopolists do not feel the whip of competition, set prices above the social optimum and have only insufficient incentives to innovate.
Customers are frequently confronted with the problem of 'switching costs'. These crop up as soon as a customer contemplates switching from one standard to another (Klemperer, 1987). The consequences of switching to a new standard may involve abandoning the old, established network/infrastructure, invalidating investments in the old infrastructure, obsolete old complements and investments in the new network/infrastructure, which might be small at the outset when the network effect, i.e. benefits, are comparatively small. In extreme cases, switching costs prevent customers from moving from an old standard to a new, technologically superior standard which might even be widely regarded as desirable. In such a situation customers are 'locked in' the old standard.
Clinging to an old standard can also be risky, however. If a large majority of users flock swiftly to the new standard, then the benefits associated with the old standard shrink rapidly, e.g. the supply of complements crumbles, service and maintenance is reduced, etc. The staunch users of the old standard are literally marooned and become 'angry technological orphans' (David, 1987, 206-239). Those who opted for the Betamax video standard at the beginning of the 1980s were soon marooned after JVC's VHS standard had gained a sweeping victory and Betamax films immediately vanished from the shelves.

5.4 Externalities and standardisation

The defining of emission ceilings (which reflect the state of the art) is one example of how standards effectively contribute to environmental protection and to the reduction of negative externalities. Externalities occur whenever the activities of one economic entity affect other entities' activities, well-being or economic interests without any compensation via the market mechanism (see e.g. Schumann, 1992, 460). As the price mechanism has no or only limited effect on such activities, the achievement of a social optimum can rarely be expected. In particular, the level of activities that bring about negative externalities will be too high, whereas the level of activities that cause positive externalities will be too low.
In this respect, standards have some advantages as compared to other regulatory instruments such as emission trading or taxation (Endres, 1994, 90; Mayntz, 1990, 137-151). In comparison to laws and directives, standards exert only a

relatively low coercive momentum. Standards are prepared on an equal footing by the interested parties and in accordance with the basic principles of standardisation (voluntary basis, open door, consensus-orientation, state of the art, etc.). The state (or governmental entities such as the EU) may occasionally take the role of a 'primus inter pares' but usually refrains from imposing standards from above and instead defines essential requirements (as in the EU case) and thus keeps regulatory intervention at a minimum.

6 Standardisation as a strategy - abstract

This section takes a closer look at the strategic dimension of standardisation. The term 'strategic' now implies that interdependencies exist between the decisions that agents make with regard to the choice of standards and/or their attributes. Interests are now assumed to be more or less conflicting and agents are choosing from a set of strategies to promote their own technologies/specifications to become (de facto) standards. The following issues will be addressed in this section:

- Strategic incentives of complementarity
- De facto standardisation in the marketplace
- Lock-in situations
- Coordination problems (bandwagon effects)
- Compatibility in the absence of network effects ('Mix and Match' situations)
- Strategic behaviour in cooperative standardisation processes

6.1 Exploitation of complementary interrelations

As mentioned before, firms that manufacture core products tend to enter the market for complements in order to consolidate their overall market position and to exploit complementary interrelations (Kleinemeyer, 1995, 18). To do so to the fullest possible extent, it is necessary to 'cut off' complements of competing producers from the firm's core product, i.e. to establish incompatibility between one's own core product and the complements of competing firms. This might for example be accomplished by introducing new interface specifications which are not made public and thus remain the exclusive knowledge of the core product manufacturer. If successful, such a firm will henceforth sell a bundle (core product 'plus' complement) and take over the whole complementary market.
This implies some risks, however, because if disgruntled users leave the complementary market, then demand for the core product can also be expected

to decline; core product and complement are now rigidly linked with regard to market dynamics. Furthermore, such forms of 'product integration' may be at odds with competition law and may entail legal action. As mentioned before, the European Court of Justice imposed a number of substantial fines on Microsoft. It was argued, for example, that the tight integration of complements such as Internet Explorer and Windows Media Player into the core product (Windows XP) constituted a distortion to competition (see e.g. World News, 2004, or Golem.de, 2004).

6.2 How to establish a de facto standard

This section discusses some typical standardisation situations with strong strategic implications. The aim of the agents involved in these situations is to seek dominance with their specifications (which might exist in the form of in-company standards) in markets where network effects are present, and to establish them as de facto standards. The following situations which are due to Besen & Farrell (1994, 117-131) are discussed in this section:

- **Tweedledum and Tweedledee:** Two firms consider it worthwhile fighting for dominance. In this classical standards battle one firm will usually come out as the winner and the other will lose.
- **Battle of the sexes:** The point of departure is similar to that of the Tweedledum and Tweedledee case; however, both firms now shy away from a standards battle and opt to cooperate. One firm turns out to be the technological leader, the other the follower.
- **Pesky little brother:** A technological and market leader cannot prevent a technological follower from plugging in and imitating its technology and snatching away some of its market share.

These situations can be nicely illustrated by methods of game theory, a (very) short introduction to which will be given in the next section. It will also outline some accompanying strategic measures, such as licensing, price and service policies, as well as give some illustrative examples.

6.2.1 The initial competitive setting

A distinction is made between two agents A and B, which may be competing firms or consortia (see Besen & Farrell, 1994, 117-131). Each agent can choose between two strategies, namely '(try to) enforce one's own technology' (a_1 and b_2, respectively), and 'adopt the opponent's technology' (a_2 and b_1, respectively). This constellation (two agents can choose between two strategies) leads to four strategy combinations, namely (a_1, b_1), (a_1, b_2), (a_2, b_1) and (a_2, b_2).

To each strategy combination, pay-offs (which also represent the terminal states of interaction) are assigned for each agent, e.g. $u_A(a_1, b_1)$ and $u_B(a_1, b_1)$ if A enforces its technology and B adopts A's technology. This initial state of affairs from which the standardisation situations in question can be easily derived is represented in matrix notation in the figure below.

Strategic situation where the firms have to decide for or against compatibility

		Firm B	
		Compatibility to firm A's design (b_1)	Enforce product design (b_2)
Firm A	Enforce product design (a_1)	$u_A(a_1, b_1)$, $u_B(a_1, b_1)$	$u_A(a_1, b_2)$, $u_B(a_1, b_2)$
	Compatibility to firm B's design (a_2)	$u_A(a_2, b_1)$, $u_B(a_2, b_1)$	$u_A(a_2, b_2)$, $u_B(a_2, b_2)$

Figure: Strategic situation where firms have to decide for or against compatibility (Source: Besen, S. M. & Farrell, J. (1994): Choosing how to Compete: Strategies and Tactics in Standardization. In: Journal of Economic Perspectives, vol. 8, 120).

The aim of game theory is to analyse settings where agents choose from some strategies and interact according to some rules (i.e. games in the broadest sense) and to identify those strategy combinations and associated outcomes which can be expected to be chosen by rational agents and can therefore be regarded as a solution to a game. One solution concept fundamental to game theory is the so-called 'Nash equilibrium': a Nash equilibrium is a strategy combination where each agent has - given the other agents' strategy choices - no incentive (in terms of a higher pay-off) to deviate from this strategy. As will be shown in the 'battle of the sexes' example, even in relatively simple game settings, multiple Nash equilibria may exist and require some kind of coordination effort among the agents. The existence of multiple Nash equilibria poses a problem and has led to the refinement of existing solution concepts and the introduction of new approaches. However, these issues will not be pursued any further at this point, as the basic Nash equilibrium serves our purposes well.
Within the given initial setting, one rather implausible strategy combination exists, namely (a_2, b_1). If the two agents choose (a_2, b_1), i.e. A adopts B's

technology and vice versa, then both agents 'miss' each other and abandon their own technology - an implausible outcome that will be ignored throughout this section.

6.2.2 The battle for a de facto standard: Tweedledum and Tweedledee

Two roughly equally powerful firms without any significant technological lead have to decide whether to enter a battle for dominance which promises a monopoly and high profits or to cooperate on creating a common standard and then compete on this basis, which yields significantly smaller profits (see figure below). Obviously, establishment of one's own standard (a_1, b_2) is a Nash equilibrium, because any deviation from these strategies does not yield a higher pay-off for either agent. It should be noted, however, that the pay-offs (100, 100) represent expected profits. Although these expected values form a basis for decision-making, the pay-offs that are actually realised after the battle turn out to be totally different. The loser of the battle, in particular, can be expected to incur losses in the first place (negative profit). Who eventually takes away victory depends to a large extent on contingencies or historical events, as will be addressed in Section 6.3.1.

The 'Tweedledum and Tweedledee' case

		Firm *B*			
		Compatibility to firm *A*'s design		Enforce own product design	
Firm *A*	Enforce own product design	50	0	100	100
	Compatibility to firm *B*'s design	50	50	0	50

Figure: The 'Tweedledum and Tweedledee' case (Source: Besen, S. M. & Farrell, J. (1994): Choosing how to Compete: Strategies and Tactics in Standardization. In: Journal of Economic Perspectives, vol. 8, 122).

Typical Tweedledum and Tweedledee strategies
In standards battles, some typical strategies are frequently applied:

(1) Speed
On a market with network effects (see Section 4.3) speed can gain the competitive edge. Firms rush to proliferate their technology in the marketplace and to build up an 'installed base', i.e. a large and stable market share, as soon as possible. Even a small lead may provide leverage in the presence of network effects (see also Section 6.3.1). Furthermore, as soon as customers are convinced of a firm's eventual success, its market share receives an additional boost, leading to a 'self-fulfilling prophecy'. Consequently, firms are eager to signal their leading market position to the customer base, e.g. by publishing sales figures. Firms also embark on an aggressive price policy which may include a price of zero for strategically critical goods such as complements ('penetration pricing', 'promotional pricing', see David & Greenstein, 1990, 13). This approach can temporarily incur losses but may eventually help to secure victory in a standards battle. For example, it is widely assumed that Sony sold the Playstation 3 at a price below the manufacturing cost in its introductory phase in order to proliferate the integrated Blu-ray technology (see Sabbagh, 2008, and Section 6.2.2.1).

(2) Product announcements
Another related strategy is given by product pre-announcements, especially 'compatible product pre-announcements' (Farrell & Saloner 1986, 940-955). These may entice customers to take a 'wait-and-see stance' and to delay a planned switch from one standard/network to another. Product pre-announcements are fairly common especially in the software and hardware industries, as can be concluded from the frequent appearances of 'vapourware' and 'ghost products' which are announced but never actually come into existence or enter the market. In the 'Vaporware Top 10', a yearly hit list published by the magazine 'Wired', the computer game 'Duke Nukem Forever' occupied the top spot in 2008 (as it had for several years running). Although Duke Nukem Forever had been under development for more than twelve years, only a few screen shots had been published until 2008 (Wired, 2008), and as things stand in 2009, the project has been laid to rest for good (see e.g. Thorsen, T., 2009).

(3) Sustainable price and service policy
Apart from penetration pricing (see above), long-term price policies may also be employed. This encompasses long-term price stability, low-prices, far-reaching promises of guarantee and commitments relating to service and updates. These measures are supposed to dispel any fears on the part of the customers that a dominant firm might abuse its ex-post monopoly, e.g. to raise prices or to reduce services. The Nintendo Wii - to stick to the realm of game consoles - is technologically not as advanced as its competitors but significantly cheaper, comes with its innovative remote control ('Wiimote') and is fully backward

compatible via its 'Virtual Console' (current versions of the Sony PS3 are not even PS2-compatible). Game console manufacturers also try to tie their customers in the long term with exclusive offers, online communities and online shops.

6.2.2.1 Case study

A much-cited example is the standards battle between Sony and JVC (Victor Company of Japan) in the market for video recorders (VCR), which started in the mid-1970s (see e.g. Rosenbloom, 1989). In 1975, Sony introduced the technologically advanced 'Betamax' system to the consumer market and tried to convince Matsushita, its strongest domestic competitor, to adopt the technology. Matsushita declined to do so, because JVC, one of its subsidiaries, was developing its own technology, namely the Video Home System (VHS). It is interesting to note that both technologies emerged from the 'U-matic format', a standard which both firms had jointly developed (Hess 1993, 56) but which turned out to be too expensive and too bulky to be successful in the consumer segment. Consensus on the Betamax system failed because it provided only one hour's playing time - too short to store movies on one cassette, whereas VHS provided 90-120 minutes' playing time. A movie-compatible playing time turned out to be the crucial factor, because it enabled the build-up of complementary markets for video cassettes and video shops.

The rise of complementary markets for the VHS system reduced the US market share of Betamax from its initial 100% to 20% in 1981. JVC also granted licences on generous terms on which firms including Hitachi, Mitsubishi and Sharp joined the VHS club at an early stage. Sony, however, being convinced of the superiority of its technology, pursued a rather restrictive licensing policy and declined to grant OEM licenses but demanded its licensees to produce Betamax players. This prevented especially small manufacturers from taking a Betamax license. Although Sony managed to win over companies like Toshiba, Sanyo and Zenith, the second biggest producer of TV sets in the United States, the Betamax coalition eventually succumbed to the VHS superiority. In 1988, VHS video recorders possessed a worldwide market share of 100%.
At the beginning of the 1970s, Philips and Grundig tried to establish their VCR system on the European market. Given a meagre playing time of 60 minutes and exorbitant prices as high as DM 140 for a blank cassette and DM 2800 for a recorder, this technology eventually failed to establish itself as well (Hess, 1993, 56). Furthermore, when technologically advanced systems like VCR-LP (VCR long-play), SVR (Super Video Recording) or the Video 2000 system were introduced, issues of backward compatibility were neglected. As a result European markets were easily seized by the VHS standard. This case study shows that in the presence of network effects even an inferior technology can - given factors such as a generous licensing policy - sweep to victory.

The latest standards war between the HD DVD and Blu-ray formats bears many similarities to the VHS vs. Betamax case - not least because some familiar protagonists, e.g. Sony, have again been involved and two technology leaders have been spearheading their respective coalitions. At the beginning of the 2000s and after some futile efforts to reach a common agreement, Sony gathered its followers in the Blu-ray Association and Toshiba its cohorts in the DVD Forum. The aim of both coalitions was to convince influential players, e.g. manufacturers of hardware and consumer electronics, software firms, film-studios, publishers and distributors, to adopt their respective technologies and to build up a critical mass of supporters. Blu-ray turned out to be the winner not only because of some performance advantages but primarily because film studios and publishers had opted without exception for Blu-ray at the beginning of 2008. However, the sequence of events will not be outlined in detail at this point; for a good starting point see Wikipedia, 2009). It should not go unnoticed, however, that one year after Blu-ray scored its victory, sales figures for Blu-ray disks and player/recorders were still low. Although the HD DVD has been defeated, customers are still mainly relying on the trusted DVD (see e.g. Heise online, 2009).
Furthermore, one influential agent that tips the balance towards one or the other format but often goes unmentioned in the literature (for obvious reasons) is the pornography industry (Guevin, 2007). Decisions made in this sector spell immediate death or secure victory for a particular technology.

6.2.3 One common standard: the battle of the sexes

In the battle of the sexes setting, both firms want to avoid an open battle for dominance. Instead, they opt for a common standard in order, for instance, to exploit network effects or complementary relationships. However, each firm prefers its own specification (which may be given in the form of a company standard) to be chosen, e.g. because adoption costs are minimised and/or property rights can be brought to bear and licenses issued. The figure below depicts the battle of the sexes setting.
In this game, two Nash equilibria exist, namely firm A (B) establishes its technology and B (A) follows. As can be seen from the pay-off structure, each firm would like to be the technology leader but prefers to be follower to no standard at all. Obviously, not a competitive, but rather a cooperative situation exists, in which it pays off for both firms to cooperate on establishing one common standard. Before standards battles break out, agents usually try cooperating to reach a common agreement on a standard (as had been the case with Blu-ray vs. HD DVD).

The 'Battle of Sexes' case

		Firm *B*			
		Compatibility to firm *A*'s design		Enforce own product design	
Firm *A*	Enforce own product design	100	50	30	30
	Compatibility to firm *B*'s design	10	10	50	100

Figure: The 'Battle of the sexes' case (Source: Besen, S. M. & Farrell, J. (1994): Choosing how to Compete: Strategies and Tactics in Standardization. In: Journal of Economic Perspectives, vol. 8, 124).

Firms strive for consensus apparently because the associated costs and risks of a standards war are considered to be to too high. The losers of a standards war have usually invested substantial sums which are sunk once and for all, while customers face uncertainty in standards battles and hesitate to switch from the old to the new standard even though it has reached de facto status and is possibly technological superior. As seen in the preceding section, customers may hesitate to adopt new technologies and prefer to rely on old standards instead.

Common strategies in the 'battle of the sexes' case

(1) Confidence-building measures
A technology leader may share its knowledge with potential partners. This may take the form of cooperation in research and development. Also conceivable is the development of a 'hybrid standard' to which both firms contribute. Both firms might also - should they fail to reach an agreement on a common standard - delegate standards preparation to a third, neutral party or resort to arbitration. In this respect acknowledged standards bodies offer a suitable framework for negotiation processes when consensus is sought among the interested parties and technical details are addressed.

(2) Licensing
Should a firm be interested in proliferating its proprietary technology on a large scale, it might (as in the 'SONY Betamax vs. VHS' case) pursue a generous

licensing policy. In an extreme case, a firm might give away its technology for free, e.g. to get the bandwagon rolling (see Schoch, 1989).

6.2.4 Asymmetrical warfare: 'the pesky little brother' case

In the 'pesky little brother' case, market asymmetry exists between the two firms involved with regard to market and standards-setting power. It is now assumed that *B* is the dominant firm whose technology can, however, be easily imitated by rivals. *B* has a well-established installed base but cannot prevent firm A from skimming off fractions of its profits, e.g. by imitating or establishing compatibility to *B*'s technology or by plugging into *B*'s network. In the Figure below, a Nash equilibrium is given by (50, 80). In this situation *B* sticks to its dominant strategy (enforcement of its own technology), but cannot prevent *A* from choosing this technology as well and snatching away profits. In such a situation firm *B* aims to prevent firm *A* from plugging into *B*'s standard/network/ infrastructure.

The 'Pesky little Brother' case

		Firm *B*			
		Compatibility to firm *A*'s design		Enforce own product design	
Firm *A*	Enforce own product design	50	80	10	120
	Compatibility to firm *B*'s design	10	60	50	80

Figure: The 'Pesky Little Brother' case (Source: Besen, S. M. & Farrell, J. (1994): Choosing how to Compete: Strategies and Tactics in Standardization. In: Journal of Economic Perspectives, vol. 8, 126).

Common strategies in the 'pesky little brother' case (for the dominant firm)

(1) Property rights
Firm *B* may use its property rights such as patents or copyrights to try to build up legal barriers to market entry. On this basis, *B* may take legal action against possible rivals.

(2) Technology changes
Firm *B* can frequently modify its technology to impose pressure on firm *A* to adapt continuously. *A* may fail to do so in a timely and proper way and thus drop behind *B*'s standard or the state of the art. Frequent technology changes can annoy customers, however, who may also be forced to adapt to new specifications on a regular basis. This problem may be alleviated to some degree by backward compatibility (see Section 4.1.3).

(3) Information policy
A restrictive information policy hampers imitators and freeloaders and helps a dominant firm to keep its technological edge. For instance, a firm may keep a technology change or the introduction of new product attributes secret as long as possible to grant imitators the shortest possible time frame for adaptation. A dominant firm that fails to fend off the bunch of pesky little brothers runs the risk of losing significant market shares and being wiped off the market in extreme cases. International Business Machines (IBM) made such an experience on the PC market, as will be shown in the following case study.

6.2.4.1 Case study

The year 1977 saw firms such as Apple, Tandy and Commodore introduce the microcomputer (Hess, 1993, 111). This class of computers still demanded considerable programming knowledge and made its breakthrough only after IBM had entered the market at the beginning of the 1980s. IBM was regarded as a powerhouse, an eminent standards-setter in its own right that would be capable of overcoming any technological and structural weaknesses in the market for microcomputers. Other manufacturers hoped to benefit from IBM's reputation and to strip microcomputers of their ludicrous reputation among users and firms. Apple even started an advertising campaign focusing on the theme 'Welcome IBM. Seriously.' (Hess, 1993, 113). When introducing its Personal Computer (PC), IBM turned out to be too powerful, however, and soon dominated the whole market for microcomputers.
IBM nevertheless faced some problems: firstly, the IBM PC was based on the open Industry Standard Architecture (ISA), which other manufacturers were able to use in order to build IBM-compatible microcomputers.

Secondly, IBM was under time-pressure to introduce its PC and strongly relied on components supplied by other producers - another important factor that

favoured PC imitators. At the beginning of the 1980s, for example, Intel provided the processors, Zenith the monitors, Shugart the disk drives and Microsoft the operating system. Only the Basic Input/Output System (BIOS) was protected by copyrights and patents (Hess 1993, 112). This presented only a minor hurdle for imitators, however, who developed their own BIOS versions and started in the mid-1980s to put IBM under pressure with their 'PC clones'. Apple maintained its own architecture and held a market share of roughly 10% in 1986; while IBM's share in the PC-market shrank from 76% in 1984 to 55% in 1986 (Hess, 1993, 114).

A number of initiatives and technological innovations (XT, AT Technology, 32-bit architecture, PS/2 product line) did not suffice to stop IBM's decline in market share and at the beginning of the 1990s it had fallen to insignificant levels. In 2004 IBM sold its PC branch (including its brand name) to the Chinese computer manufacturer Lenovo.

6.3 Comprehensive strategies in industries with network effects

This section addresses some market structures and attributes which are strategically relevant but may be influenced by a firm only to a limited degree:

- **Lock-in effects:** The term 'lock-in' denotes the market participants' unwillingness to switch from an old, inferior standard to a new, superior standard, even though such a move is basically endorsed by the relevant agents. This is caused by the network effects that the old network exerts together with the associated switching costs.
- **Bandwagon effects:** To establish new technologies and standards in the marketplace an impulse is needed which triggers and accelerates demand and builds up an installed base. These dynamics are called bandwagon effects.
- **Mix and match:** Compatibility can be beneficial even if no network effects are present. Audiophiles, for instance, can combine the components of different manufacturers to assemble a hi-fi system which exactly matches their preferences. This combination of subsystems of different origins to create a tailor-made system is called 'mix and match'.

In most cases a firm has only limited control over some market attributes and has to realign its strategies accordingly. It is crucial for a firm to know and understand the given market attributes and to utilise them to the best possible degree. This section addresses those market attributes which are both directly and indirectly related to technology choice and standards choice, especially on markets with network externalities.

6.3.1 Lock-in effects

A market is said to be locked in a technology if network effects have reached such an extent that new users opt for the technology without exception and decide against other competing technologies (David & Greenstein 1990, 6). A lock-in is induced by network effects and also affects users who would actually prefer other technologies in terms of stand-alone values. A lock-in corresponds to a solid installed base and often leads to a de facto standard.

Not only network effects play a role but also historical events and user expectations about future developments (see Arthur 1989). Some expectations may become self-fulfilling ('self-fulfilling prophecy') if a sufficient fraction of the user base is convinced of a particular technology's success and reinforces its network by choosing accordingly, thus triggering a feedback loop.

A technologically superior innovation cannot make its breakthrough because an established technology's installed base is too big at the point of time T*. Although the new technology promises much higher benefits than the old technology it cannot gain any momentum in the marketplace. The reason is that, from time T* onwards, the old technology has generated sufficiently high network effects to forestall any attempts to a achieve technology change. Although the new technology could generate higher benefits with the same installed base, individual users have no incentive to abandon their old technology because they would forgo its high network utility.

6.3.1.1 Lock-in by historical events - a model

To illustrate how issues of de facto standardisation are addressed in economic theory, the following outlines a model by Arthur (1989). Two technologies, A and B, compete on a market that has two different types of user, R and S. The populations R and S are assumed to be large and of equal size. R and S types enter the market in a random sequence and opt for technology A or B. From the assumption made above (large and equally sized R and S populations), it follows that at any point of the user sequence an R type (or S type) user enters the market with a probability of ½. On entering the market, R and S types assess their options by comparing the utility functions given in the figure below and choose the technology which yields the higher utility.

Return to choosing A or B given previous adoptions

	Technology A	Technology B
R-agent	$a_R + rn_A$	$b_R + rn_B$
S-agent	$a_S + sn_A$	$b_S + sn_A$

Figure: Return to choosing A or B given previous adoptions (Source: Arthur, B. W. (1989): Competing Technologies, Increasing Returns and Lock-in by Historical Events. In: The Economic Journal, vol. 99, 118).

It is assumed that $r,s > 0$ (positive network effects) and $a_R > b_R$ and $a_S < b_S$, respectively, i.e. R types have a bias towards technology A, and S types a bias towards technology B. As can be seen from the figure above, users who enter the market at position $n + 1$ take into account how their n predecessors have decided. An R-type user will - despite a preference for A - opt for B if the following relation holds:

$$n_A(n) - n_B(n) < \frac{b_R - a_R}{r}$$

Equally, an S-type user will - despite a preference for B - opt for A if the following relation holds:

$$n_A(n) - n_B(n) > \frac{b_S - a_S}{s}$$

Both inequalities define upper and lower absorbing barriers. If $n_A(n) - n_B(n)$ falls below $(b_R - a_R)/r$ (or exceeds $(b_S - a_S)/s$), then the market is locked in technology B (or A, respectively). Due to the dominant network effects, every subsequent user will opt for B (or A).
Stochastically, the difference $n_A(n) - n_B(n)$ performs a one-dimensional random walk with absorbing barriers and the probability ½ that an R or S type user will enter the market at the n-th position (See Wikipedia (2009) for an introduction to random walks: *http://en.wikipedia.org/wiki/Random_walk, 2 July 2009.*) The result of such a random walk depends on the individual case, i.e. the parameter values of the given utility functions and the sequence in which users enter the

market. It is also possible that an absorbing barrier is never transgressed. An example of the path such a random walk can take is given in the figure below.

Increasing returns of adoption: a random walk with some barriers

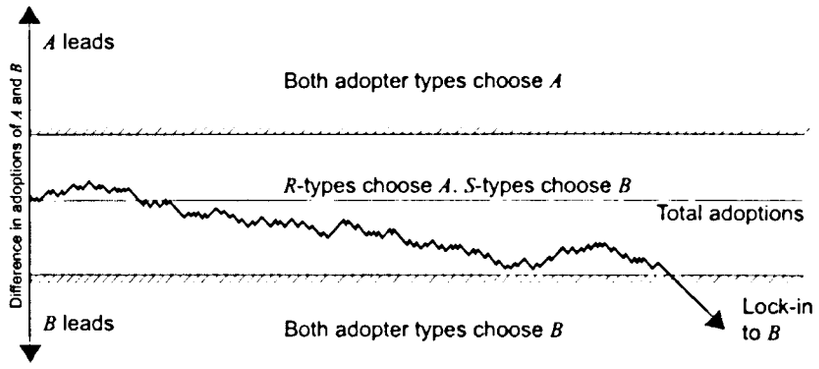


Figure: Increasing returns of adoption: a random walk with absorbing barriers (Source: Arthur, B. W. (1989): Competing Technologies, Increasing Returns and Lock-in by Historical Events. In: The Economic Journal, vol. 99, 120).

6.3.1.2 Case study

An often-cited example of an inferior specification which nevertheless managed to become a standard is the QWERTY keyboard for typewriters and computers. Eponymous for this standard (which is based on a patent of 1867) is the letter sequence 'QWERTY' in the upper left corner of the keyboard. The aim of the QWERTY keyboard was to reduce writing speed because the typebars in old typewriters tended to jam and interrupt the flow of writing.
However, with the advent of innovations such as daisy-wheel typewriters and golf-ball typewriters, artificial speed reduction became obsolete (Knie, 1992, 161-172). For this reason new keyboard designs like the 'Ideal Keyboard' were introduced at the end of the nineteenth century. This keyboard featured the letter sequence 'DHIATENSOR' at its centre, with which 70% of English vocabulary can be typed (David, 1986, 30-49). In 1932 the 'Dvorak Simplified Keyboard' (DSK) was introduced and broke every speed record. The question now is why the DSK (the superiority of which, however, is not entirely undisputed, see e.g. Liebowitz & Margolis 1990, 1-25) or other keyboard designs failed to succeed in replacing the QWERTY keyboard.

The global dominance of the QWERTY keyboard is the result of lock-in effects (David 1986). Users avoid switching because they have only limited information about the cost-benefit ratio of such a move or assess learning costs as too high (Farrell & Saloner 1985), while manufacturers and firms fear for their investments in the old standard. In principle, the QWERTY standard is taken for granted and nobody seriously considers introducing an alternative design. How deeply rooted the QWERTY keyboard is in society can also be seen by the fact that it has been incorporated in acknowledged standards (see Kleinemeyer 1997, 55 and DIN 2137-1:1995-07: Text and Office Systems - Keyboards).

6.3.2 Coordination issues and 'bandwagons'

'Penguins gather on the edges of ice floes, each trying to jostle the others first, because although all are hungry for fish, each fears there may be a predator lurking nearby (Farrell & Saloner, 1987, 13).'
The above quote refers to the specific coordination problems that frequently occur when new technologies are about to be introduced. In a situation of this kind, users have to decide whether to stick to the old standard or to switch to the new standard. This is by no means trivial as an established network can exert strong positive network effects and induce significant switching costs (Katz & Shapiro, 1985, 424-440, and Farrell & Saloner 1985, 70-83), and should only a small fraction of the user base choose to switch from the old to the new technology then the associated network externalities might be too small to compensate for the expected switching costs. Firms face similar issues when investment decisions are made with regard to new technologies. For this reason only two equilibria are conceivable in the long run: either the whole consumer base sticks to the old standard or the whole consumer base switches to the new standard. But how do the related decisions come about?
During the transition from the vinyl record to the CD, record collections and record players became obsolete while a CD collection had to be built up and a CD player be acquired. However, the CD standard easily swept to victory. On the other hand, transition from the DVD to the Blu-ray Disk is not exactly proceeding smoothly. The reason for this is that the move to the new standard is still relatively costly and many users continue to rely on the trusted DVD, which for many still meets their demands (see Heise online, 2009).
According to Granovetter and Soong (1986, 83-99) and in a similar way to Arthur (1989), there is a threshold value with regard to the number of users. As soon as this value is exceeded, the rest of the user base will follow suit; otherwise the old standard will prevail. According to Farrell & Saloner (1985b), users will switch to the new technology if this implies long-term benefits and each user has full information on the behaviour of other users. Because this is impossible in most cases, users make conjectures about the switching decisions that other consumers are going to make, which may result in a gradual technology change comparable to the domino effect as soon as users tend to favour the new

standard. The first to change are users who derive a relatively high, network-independent, stand-alone value from switching while those users who depend more on the network externalities follow later.

The dynamics involved in overcoming coordination problems of the above sort are summarized in the term 'bandwagon', because the more users have jumped the train, i.e. opted for the new standard, the more attractive it is for the rest of the user base to do so as well (Farrell & Saloner 1986a, 940-955; 1986b, 71-74). A characteristic of a bandwagon is that 'early adopters' can exert a strong leverage effect and considerably influence the switching decisions that the rest of the user base makes. However, given the uncertainty about the behaviour of other users, the following two situations may occur: firstly, because there is widespread uncertainty about the result of an impending standards war and potential first-movers are doubtful whether other users will follow their example and switch, no-one dares to take the first step and the market remains in a state of 'excess inertia'. In this case users avoid the risks of early adoption and observe the behaviour of other users (see the quote above). Excess inertia can occur even though the user base would actually appreciate switching to the new standard. Notwithstanding, a single user has no incentive to make the first move and get the bandwagon going (Farrell & Saloner 1985, 70-83). Secondly, 'excess momentum' may occur if early adopters entice other users to switch, even though this is not in their (long-term) interest. Excess inertia and excess momentum are not confined to the first stages of standardisation processes and can also occur in later stages, e.g. due to historical events (Postrel, 1988).

Furthermore, an improved information exchange does not always suffice to solve coordination problems of the above kind. Farrell and Saloner (1986a and 1986b) show that 'complete communication', i.e. communication that leads to a state of complete information, can solve the coordination problem if the new standard is beneficial for all users. This does not hold, however, if preferences differ. In this case, communication among users can be employed by individual users or coalitions for manipulative purposes, i.e. to build up excess inertia or excess momentum. However, not all attempts to manipulate users turn out to be successful: '*Every steam carriage which passes along the street justifies the confidence placed in it; and unless the objectionable feature of the petrol carriage can be removed, it is bound to be driven from the road, to give place to its less objectionable rival, the steam-driven vehicle of the day* (William Fletcher 1904, 11).'

A 'wait-and-see-strategy' is ambivalent: The longer a user waits to decide to switch from the old to the new standard, the smaller the risk of making the wrong decision, i.e. of becoming an angry technological orphan or of switching to a technology that does not generate sufficient network externalities. A user who waits too long to switch, on the other hand, foregoes bargains and opportunities that firms offer (e.g. in the form of penetration pricing to build

up an installed base). The optimal point in time prevails if the sum of the expected costs of choosing the wrong technology and the costs of switching to the superior technology is minimised.

6.3.2.1 Case study

Some coordination problems cannot be solved by competition/market mechanisms, as the following example shows (Kleinemeyer 1997, p. 133). The transition from leaded to unleaded petrol proceeded sluggishly from the outset. Filling stations did not offer unleaded petrol because no suitable engines were available, and motorists avoided buying cars designed for unleaded petrol because filling stations were not offering unleaded petrol. Given the sluggish demand on the marketplace, car manufacturers declined to produce 'unleaded models' on a grand scale. Only after the legislator imposed legally binding requirements were the relevant agents prepared to agree on common standards with regard to unleaded petrol. Similar reasons mean that alternative fuels are struggling to be widely accepted.

6.3.3 Compatibility and combinatorics: mix and match

Up to this point compatibility has mainly been addressed in the context of network structures, i.e. the presence of network externalities has been assumed which give rise to specific market dynamics. As an example, horizontal and vertical complementary relations have also allowed small firms to benefit from the market success of big standards-setting firms. However, compatibility can also be beneficial when network effects are absent. For instance, standardised interfaces allow users to choose from different modules or components (of different manufacturers) in order to assemble a system that complies with their demands. This is called 'mix and match' (Matutes & Regibeau, 1987; 1988). It is the principle that allows audiophiles to tailor hi-fi systems to their preferences without incurring additional adoption costs. Such choice options raise users' willingness to pay for single components, from which manufacturers immediately benefit. With compatibility absent, users have to rely on prefabricated, integrated and inflexible systems (e.g. compact systems), or may only combine components within the product range of a single manufacturer (as is common with cameras and lenses). Matutes & Regibeau additionally show that when there are two producers, welfare is enhanced and prices rise if both firms establish compatibility between their respective components. Economides (1989) investigated markets where only partial compatibility existed and came to the conclusion that full-scale compatibility is usually welfare-enhancing. An exception may be seen in the case of 'hybrid systems' (systems such as hi-fi systems which consist of different manufacturers' components). If the demand for such systems is small, the gain in compatibility may not suffice to compensate for the ensuing increase in competition.

6.3.4 The relevance of property rights for product life cycles

Reference to the product life cycle approach, which divides a life cycle into the market introduction stage, the growth stage, the mature stage and the saturation stage and decline stage, can be used to illustrate the relevance of standardisation at different time points in a product's life. One common trend is basically that the further a product's life advances, the higher the degree of standardisation, while network effects may affect every stage of a product's life cycle. In the introduction stage, intellectual property rights (IPR) such as patents and copyrights protect a firm's technology. In the growth stage, 'secondary property rights' such as brands or proprietary names start to play a role, while in the mature stage, 'tertiary property rights' such as standards tend to dominate: 'The regime of property rights is replaced by a regime of standards (Bonner, 1994, 7).'

A firm that owns a set of property rights will usually try to exploit these rights for as long as possible. This corresponds to the competition in a market with the strategic goal of dominance. In the case of network effects, however, competition for a market plays an important role. The firms involved try to establish an installed base as soon as possible to exploit positive feedback loops. This is why some firms may forgo some of their property rights and share their technologies, e.g. with licensees, in order to penetrate the market and to set a de facto standard.

6.3.5 The lifetime of property rights

Apart from the duration of the individual product life cycles (see Section 6.3.4), the lifetime of the associated property rights also plays an important role. The lifetime of patents, in particular, has a significant impact on a firm's decision to invest in research and development. The high level of protection of intellectual property which the legislator grants offers an incentive to invest in product and process innovation and to generate new know-how (Kleinemeyer, 1997, 192). The aim is to grant firms exclusive rights to exploit their innovations over a specific period (i.e. the lifetime of a relevant property right), to recuperate investments and to gain some profits. To summarise, property rights, such as patents, grant innovators exclusive authority to exploit their knowledge economically.

On the other hand, the dissemination and application of newly generated knowledge has particular significance for social welfare (Weiss, 1992, 3). Property rights may encourage innovations but also create barriers to trade and favour the emergence of monopolies. Exclusive (intellectual) property rights thus give rise to an obvious conflict of goals: creating incentives to innovate on the one side and making as much knowledge freely available to society

as possible on the other. To address this trade-off, the lifetime of property rights provides a convenient control variable which allows for the tweaking and comparison of social costs and benefits accompanying the different property right regimes. The social benefits, as mentioned above, derive from an increase in innovative activities which are spawned by the right to appropriate and internalise the associated profits. Social costs are induced by the privileged position that an innovator can exploit, e.g. by setting prices above (and supply below) the social optimum (as compared with the case of perfect competition) and the suboptimal degree of knowledge dissemination. The challenge (or optimisation programme) is to set the duration of property rights in such a way that the difference between social benefits and social costs is maximised - a situation that prevails if the difference between the social marginal benefits and social marginal costs equals zero.

The resultant optimal duration of a property right is usually dependent on the given context (e.g. the industry in question or the type of innovation). In Germany patents are valid for 20 years - irrespective of circumstances such as the specific industry or technology (Patentgesetz 1981: §16 para. 1). The fact that such a static approach to patent validity may be out of date and inappropriate is underlined by the following quote (which is geared to US patent law, but nevertheless also holds for the German regime): '[...] *patents expire after 17 years, a period that made sense when scientific knowledge doubled every 100 years, instead of today's doubling every three years, if not every three months. Copyrights, conversely, last for the life of the author plus 50 years [...]. Considering the degree of obsolescence of most software and hardware, this is also too long* (Gervaise Davis III., 1993, 21).'

Given the fact that standards provide a storage medium for common knowledge, are freely available and possess many characteristics of a public good (Kleinemeyer 1997, p. 127), they appear to be the natural antipodes to (intellectual) property rights such as patents which, as had been shown above, provide their holders with certain exploitation rights. Indeed, it can be regarded as an ethical principle in standards preparation to rely as much as possible on freely available knowledge and existing standards. However, in the preparation of advanced standards (as, for example, in the ICT branch) reference increasingly has to be made to proprietary specifications and technologies. To encourage firms to contribute their (possibly crucial) specifications and technologies to a standardisation project which accords with the basic principles of standardisation, and to forego possible exploitation opportunities, standards bodies have designed appropriate IPR policies (see the following section).

6.4 Strategic behaviour in standardisation processes

Up to this point, consideration has primarily been given to standardisation strategies in the market realm. Nevertheless, firms have an incentive to behave strategically in other contexts of standardisation, especially in standardisation processes under the auspices of (acknowledged) standards bodies. Mere participation already provides a firm with certain benefits, e.g. an information advantage over non-participating firms and the opportunity to actively influence the design of a standard. In standardisation processes, firms usually try to push through their specifications (which may exist in the form of in-company standards) and to manipulate the resultant standard towards their own interests. It is also quite conceivable for firms to participate in standardisation projects only to obstruct standards preparation and/or to prevent a standard from being published. Firms may resort to obstructive strategies if they consider a prospective standard to be a threat to their own favourable market position.

In standardisation processes the following scope for strategic behaviour exists: basically, the generally open and consensus-based standardisation process in acknowledged standards bodies and consortia is sensitive to strategic and opportunistic behaviour. As decisions are being made according to the consensus-principle (qualified majority voting is only a last resort), it is relatively easy to stall or slow down a standardisation process with vetoes, new suggestions, proposals or petitions. It is possible, for example, that some participants may have voted 'yes' on a draft standard in the Technical Committee, and finally 'no' in the steering committee responsible for policy (usually the General Assembly). Schmidt & Werle (1997, 181) refer to such a case in international telecommunications standardisation.

Indeed, convincing arguments, technical expertise and soft skills (e.g. negotiating skills) can help a firm to make its point and be successful at the negotiating table. Some agents, however, resort to more robust instruments to push through their interests. Influential agents, for example, may impose pressure on weaker agents, forge alliances behind closed doors (backdoor policy) and opportunistically coordinate their behaviour in order to exploit weaknesses in the standardisation process.
Some firms are powerful enough to seize and abuse entire, formally independent standardisation infrastructures to approve their own specifications as an (acknowledged) standard. Indeed, this is perfectly irreconcilable with the basic principles of standardisation and their emphasis on equal rights and cooperation. As a case in point, many pundits hold the view that Microsoft severely violated the basic principles of standardisation when its 'Office Open XML Standard' was fast-tracked to become an acknowledged International Standard (see e.g. Heise Online, 2008, or GROKNET, 2008).

In ICT standardisation, especially, reference is increasingly being made to proprietary specifications and technologies owned by specific firms. Such firms possess significant bargaining power - especially if they own a bottleneck technology - and may be unwilling to share their expertise with other firms and potential rivals. To encourage such firms to participate and to avoid the threat of 'patent trolling', Standards bodies such as ETSI or the World Wide Web Consortium (W3C) have devised IPR policies which grant licence fees to the owner of a bottleneck technology, e.g. according to the 'RAND principle' (RAND: Reasonable and Non Discriminatory Licensing) or rule out any payments (see e.g. W3C, 2004).

Agents who are dissatisfied with the course of events may also be able to leave a standardisation process and initiate a consortium or a standardisation process in a standards body that better suits their interests. As soon as this happens, two similar standardisation processes start to compete.
In comparison to acknowledged standards bodies, consortia are fairly flexible with regard to their institutional attributes. The founders of a consortium may depart from the basic principles of standardisation in one way or another (e.g. by abandoning the consensus principle) and favouring an accelerated standardisation process. Although adherence to the basic principles of standardisation provides acknowledged standards bodies with a higher degree of legitimacy, it also usually results in a longer average preparation time for standards.
Firms may also have the opportunity to shape the institutional features of standardisation processes. For example, as a full member of a standards body, a firm has the (legitimate) right to jointly decide on the strategic or political orientation that standardisation activities should take or to shape the standardisation process. Such rights are granted in the statues and rules of procedure of acknowledged standards bodies such as DIN.

Participation in standardisation processes not only brings some (strategic) advantages, but also some (practical) disadvantages which may have a detrimental effect on a firm's willingness to participate. These include the costs of membership in standards bodies or the direct costs of participation in a standardisation project. The latter may be incurred in the form of travel costs or non-productive time of those employees who participate in standardisation projects. Quite often, there may be no perceivable immediate and tangible benefits associated with standardisation activities to offset the costs incurred. This frequently induces decision-makers, especially those with a non-technical background, to opt out of any engagement in standardisation. Against this backdrop, standards bodies - which crucially depend on the expertise provided by firms - keep emphasising the strategic relevance and the benefits of standardisation as such and the engagement in standardisation processes in their annual reports and policy documents.

7 Concluding remarks

This teaching module has outlined the strategic significance of standardisation. In technologically advanced fields such as ICT, in particular, standards have a significant impact on market emergence and market attributes. Compatibility standards, for example, are an essential constituent of networks and networks effects, which in turn favour the dominance of one technology and of the de facto standard and its proprietor. As dominance in such growth markets promises an almost incontestable market position and exorbitant profits, firms apply the whole set of strategies at their disposal to win the 'standards war', although contingencies like historical events play a significant role and may eventually tip the balance towards one particular technology. In this case, the repertoire of strategies goes beyond mere market strategies and may also encompass measures such as legal action against rival firms or strategic and opportunistic behaviour in standardisation processes. In view of the ever-growing importance of standardisation in various fields of technology and industries, and because standards battles like the recent Blu-ray vs. HD-DVD issue occur on a regular basis, a consolidated knowledge of the underlying mechanisms is indispensable - not only for firms but also for every entity affected, namely users, consumers, students, scientists, regulators and policy-makers. Imparting such knowledge has been the aim of this teaching module.

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9 Glossary

Acknowledged/formal standards
Acknowledged standards or formal standards are standards prepared according to the principles of 'due process'/the basic principles of standardisation in Technical Committees under the aegis of an acknowledged or formal standards body such as DIN, CEN or ISO. Acknowledged/formal standards may not necessarily differ in terms of content from publicly available standards or technical specifications that consortia publish, but do exhibit a higher degree of legitimacy and may be referred to in regulatory or legal affairs.

Acknowledged/formal standards bodies
Acknowledged or formal standards bodies exhibit a number of institutional similarities and prepare standards according to the principles of 'due process'/the 'basic principles of standardisation'. Such standards bodies are acknowledged by the state or supranational governmental bodies such as the EU (which has acknowledged the European standards bodies CEN, CENELEC and ETSI) as partners, e.g. in regulative affairs and legislation. They are granted specific rights (e.g. the right to represent a national standardisation system on the international level or financial support). International formal standardisation bodies are indirectly acknowledged by the states which participate in international standardisation and apply international standards, and the World Trade Organization (WTO) which refers to international standards in its efforts to liberalise international trade.

Adoption costs
Adoption costs are incurred by consumers, customers or consumers by tweaking a (more or less standardised) product to match their actual preferences/ needs.

Akerlof equilibrium
This is the terminal state that an Akerlof market reaches after adjustment processes have come to an end: only the low-quality sellers remain in the market while the high-quality sellers have been driven out.

Angry technological orphans
Users who cling to an old standard or technology run the risk of being sidelined if a majority of users flocks swiftly to the new standard. In such a case, the benefits associated with the old standard shrink rapidly, e.g. the supply of complements crumbles, service and maintenance is reduced, etc. The staunch users of the old standard are literally marooned and become 'angry technological orphans'.

Architecture
See 'systems architecture'

Backward compatibility
'Backward compatibility' denotes the compatibility of a given core product with older versions of its complementary product range.

Bandwagon (effect)
The more agents 'jump on the bandwagon', i.e. make the same choice among competing choice options, the more attractive this choice option becomes to other agents.

Basic-Input/Output-System (BIOS)
The basic input/output system is the first program code that is executed when a PC is switched on. It identifies, initializes and tests the hardware components of the PC (e.g. storage media, video cards) and sets it in a 'known state' from which other software, especially the operating system, can be loaded. Basic input/output systems a proprietary and have become de facto standards (source: Wikipedia, *http://en.wikipedia.org/wiki/BIOS*).

Basic principles of standardisation
The basic principles of standardisation encompass a number of institutional features which are common to most (formal) standards bodies and many fora and consortia. These principles are voluntary basis (of participation and standards application), transparency of/open book in standardisation processes, open door, uniformity and consistency of standards repositories, consensus as the prevailing decision making mechanism, reference to the state of the art in science and technology, primacy of public interest, primacy of international standardisation.

Bottleneck technology
A bottleneck technology is a technology or specification which is indispensible in a standardisation project and to which an agent (usually a firm) holds intellectual property rights. The holders of a bottleneck technology wield considerable influence in a standardisation process and may bring it to a standstill, should they be unwilling to contribute the bottleneck technology to the standardisation effort.

Bundeskartellamt
The 'Bundeskartellamt' is the German federal competition authority.

Bundle
In a bundle, core product and complementary product(s) are combined into an entity and shipped as such.

CE Mark
CE stands for Conformité Européen (European Conformity). The CE mark - also CE conformity mark - indicates that - according to the manufacturer/importer -

a product complies with the requirements of the relevant New Approach Directives. Therefore, to a certain extent, the CE mark functions as a 'passport for the free movement of goods in the EU'. In the case of products that are covered by a number of directives, the CE mark indicates that the requirements of all the directives concerned have been met. Each directive lists the conditions that have to be observed in CE marking. The manufacturer/importer bears the responsibility for affixing the CE mark after the requirements have been fulfilled. N.B.: The CE Mark is a sign of conformity with directives and not a quality mark or standards conformity mark.

CEN (European Committee for Standardization)
The European Committee for Standardization or Comité Européen de Normalisation (CEN), is a private non-profit organisation whose mission is to foster the European economy in global trading, the welfare of European citizens and the environment by providing an efficient infrastructure to interested parties for the development, maintenance and distribution of coherent sets of standards and specifications (source: Wikipedia, http://en.wikipedia.org/wiki).

CENELEC (European Committee for Electrotechnical Standardization)
CENELEC (Comité Européen de Normalisation Électrotechnique) is the European Committee for Electrotechnical Standardization. CENELEC is responsible for European Standardisation in the area of electrical engineering. Together with ETSI (telecommunication) and CEN (other technical areas), CENELEC forms the European system for technical standardisation
(source: Wikipedia, http://en.wikipedia.org/wiki).

Committees/standards-setting committees
Standards Committees (or technical committees) form an organisational core element in standards developing organisations. In formal standards bodies, for example, technical committees consist of experts who voluntarily participate in standards preparation. Technical committees also have a chairperson, who functions in the first place as a mediator, and are supported by a secretariat. The decision-making mechanism of choice is the consensus principle, with qualified majority voting being only a last resort.

Committee Standardisation
Committee Standardisation is an umbrella term for any cooperative, consensus-based approach to standards preparation. It encompasses standardisation both in formal standards bodies as well as in consortia and fora.

Committee standard
A committee standard has been prepared in a committee setting, i.e. in a cooperative, consensus-based approach and in accordance with the basic principles of standardisation (e.g. consensus, transparency and openness).

Company standardisation
The term company standardisation denotes every form of standardisation that takes place in a company.

Company standards, in-company standards
Company standards are standards that are applied within a company. Company standards are usually mandatory within a company, and may be in-house developments or imported from the outside (e.g. ISO standards).

Compatibility
Compatibility is established via interface standards that link technical systems and/or agents which are enabled to exchange matter, signals and energy.

Competition for a market
Competition for a market implies manipulating the basic attributes of a market in favour of one firm or another. This may take the form of lobbying, influencing the regulatory framework, exploiting network effects as well as preparing standards as essential constituents of certain markets.

Competition in a market
Rival firms compete in a market (e.g. by price-setting or product differentiation) and take the basic attributes of a market (e.g. market form, regulatory framework, relevant set of standards) as given. This is the common form of competition and takes place when no competitor has the power to manipulate the basic attributes of a market.

Complement, complementary product
A complement is a product (or subsystem) which depends on a core product (or core system) to be fully functional. Core product and complementary products are interconnected via interfaces and exchange matter, signals and energy. For example, a computer can be regarded as a core product and the software which runs on it as its complement.

Complementarity
Complementarity exists when different products/systems with different, complementary functionalities can be combined to achieve full functionality of the product combination/super system.

Complexity management
Firms are confronted with an ever-increasing level of complexity which is induced by a number of external and internal factors, such as customer demands, the legal framework, product diversity/variety, production processes, and which has to be addressed appropriately. The methods of (company) standardisation are an especially powerful instrument to reduce variety-induced complexity.

Component
A component is an element which can be combined with other, compatible components (of the same or a different type) to create a system or product. For example, one may regard a brick as a component of a building.

Conformity
A product, object or process conforms to a standard if it fulfils the requirements laid down therein.

Conformity assessment
As stated in the CEN guidance document GD - Product standards and conformity assessment dated 2004, this is any activity concerned with determining directly or indirectly that relevant requirements are fulfilled. Typical examples of conformity assessment activities are sampling, testing and inspection; evaluation, verification and assurance of conformity (supplier's declaration, certification); registration and approval as well as their combinations (see http://www.cen.eu/BOSS/supporting/guidance+documents/gd031+-+product+standards+and+conformity+assessment/gd+-+product+standards+and+conformity+assessment.asp for details).

Consensus principle
General agreement, characterised by the absence of sustained opposition to substantial issues by any important part of the concerned interests, and by a process that involves seeking to take into account the views of all parties concerned and to reconcile any conflicting arguments (ISO/IEC Guide 2:2004, EN 45020:1998, 1.7, CEN/BOSS Glossary: http://www.cenorm.be/BOSS/glossary.asp). Consensus does not necessarily imply unanimity.

Consortium
In the narrowest sense (see Egyedi & Hawkins, Chapter X), the term 'standards consortium' refers to an alliance of companies and/or organisations that aims to develop publicly available standards or technical specifications for the purpose of coordinating technological and market development in a specific ICT area. In the wider sense, the term standards consortium refers to all non-formal organisations and alliances that develop publicly available standards or technical specifications for the purpose of coordinating technological and market development activities. The term consortium, as defined by CEN, is an organisation that is not formally recognised as a 'promulgator' of public standards, but formed for the purpose of developing common technical specifications for the use of its members, usually in narrowly defined areas (CEN/BOSS Glossary: http://www.cenorm.be/BOSS/glossary.asp.

Consortia standards, consortia agreements
These are normative deliverables, such as technical specifications or publicly available standards, that consortia prepare and publish; they are to be distinguished from acknowledged or formal standards.

Contestable market
A contestable market is a monopoly market on which the incumbent monopolist has to behave as if he/she is facing perfect competition, i.e. to set prices at competitive levels. Any increase in prices immediately attracts competitors who enter the market and force prices down to former levels. See especially Baumol, W. J. (1982): Contestable Markets: an Uprising in the Theory of Industry Structure. In: American Economic Review, 72 (1), p.1-15.

Core product
A core product is a product which interoperates with and provides basic functionalities for compatible complementary products. Core product and complementary products are interconnected via interfaces and achieve their full functionality only as an entity.

Corporate strategies
Corporate strategies are action plans that firms or corporations devise in order to reach long-term goals. In (corporate) strategies, the behaviour of other relevant agents, especially rival firms, is taken into account and provisions for contingencies are made. (Corporate) strategies are usually directed at the marketplace but may also include lobbying, legal action or specific activities in other fields, e.g. standardisation. Strategies also have an impact on the internal structure, (production) processes or the product range of a firm. Typical examples for corporate strategies are cost leadership or differentiation.

Cost leadership strategy
A company aims to produce at a lower cost per unit than rival firms. This opens up scope to set prices lower than those of competing firms. Company standardisation proves to be an especially powerful instrument of rationalisation and directly supports the aim of cost leadership.

Cost-benefit (analysis/comparison)
In a market-based society the comparison of costs and benefits (or cost-benefit analysis, in a stricter sense of the word) provides a fundamental feasibility criterion. Any economic activity is only viable in the long run if the benefits (usually defined in monetary terms) exceed the costs in the long run.

Customisation
Preparing or altering the product or service according to the requirements of the customer.

Dated direct reference method
In the dated direct reference method the number of the standard, its title and date are quoted in legal texts and laws.

De facto standard
A de facto standard is a specification or technology that has not officially been passed by a standards body (e.g. a formal standards body or consortium) but is nevertheless well-established and widely applied among the user base. De facto standards are not the result of committee standardisation but emerge from other settings, such as markets, and depend on the choices and interactions of the relevant agents (e.g. firms and users, as well as e.g. regulators or the judiciary who set the institutional framework). The emergence of de facto standards is especially favoured on markets where network effects are present.

De-jure standards
The term 'de-jure standard' was introduced in the late ninety eighties in an economic context. It subsumes so-called 'mandated standards' (hierarchy standards) and 'standards agreements' (formal standards) and may be distinguished from de facto standards. This term is ambiguous, however, because standards are usually applied on a voluntary, i.e. 'non-de-jure' basis. Many authors therefore recommend avoiding this term.

Differentiation strategy
A company aims to offer goods which are different/better than rivals' goods. This is achieved by superior product quality or superior product attributes which other comparable products do not feature.

Direct network effects
Direct network effects arise when users benefit from being linked, physically or psychologically, to a large number of other agents. For example, in the case of phone or e-mail networks, because consumers want to be able to communicate with a large group, they would perceive a larger network benefit as the number of network users increases.

DIN
The 'Deutsches Institut für Normung e.V.' (DIN) was founded in 1917 under the name of the 'Standards Committee for General Mechanical Engineering' and is the national standards organisation in Germany. The DIN is a registered technology and science association with its own legal personality and operates on a non-profit-making basis. The job of the DIN and its subsidiaries is to elaborate technical rules, with assistance from all the interested groups (businesses, organised interest groups, the state), on the basis of consensus and transparency and to support their application.

Dominance strategy
Dominance is based on a superior design and/or exclusive property rights which distinguish a product from rival products, reduce the market shares of rivals and impose market entry barriers. A dominant design may promote a firm to become market leader. The classic example is Microsoft which applied various (and sometimes dubious) strategies to build up a dominant position in the PC operating system and PC software markets

Dominant design
The distinctive way of providing a generic service or function that has achieved and maintained the highest level of market acceptance for a significant amount of time (Lee et al., 1995, p.6).

Draft standard
A draft standard is an 'intermediate product' of the (formal) standardisation process and usually prepared by a technical body (e.g. a working group or a technical committee). This 'prototype' of a standard is fed into the next production stages of the standardisation process, e.g. the public inquiry phase or the approval stage. A draft standard may also be published, e.g. as a technical specification.

Dynamic complementarity
Dynamic complementarity exists when a core product is compatible with old and/or forthcoming versions of a complement, although these complements have been or will be basically designed to interoperate with other core products/platforms.

Ecological standard
An ecological standard defines ecological safety requirements, for example in form of emission ceilings for hazardous substances, that a product, process or activity has to meet in order to comply with the standard. In this case, the product, process or activity can be certified accordingly and expected to perform within certain ecological safety margins, in line with the state of the art.

Economic effects of standardisation
The economic effects of standardisation are (among others): cost reductions/ efficiency gains in production, economies of scale, market creation, market integration, constitution of networks, compatibility of technical systems, enhanced interoperability.

Economic benefits
Economic benefits may accrue to consumers in the form of higher income and/ or reduced prices, and to firms in the form of reduced costs/higher profits.

Economies of scale
The increase in efficiency of production as the number of goods being produced increases. Typically, a company that achieves economies of scale lowers the average cost per unit through increased production since fixed costs are shared over an increased number of goods. Economies of scale give large companies access to a larger market by allowing them to operate with greater geographical reach. But for the more traditional (small to medium) companies, size does have its limits, so, after a point, an increase in size (output) actually causes an increase in production costs. This is called 'diseconomies of scale' (source: Investopedia, http://www.investopedia.com).

Emission trading
Emission trading is a market-based approach which aims at a socially optimal allocation of rights to emit a limited amount of a pollutant. These limits are set independently by a state authority or an international body, while the rights to emit the pollutant are tradable. Hence, a market is created on which prices for the rights to emit the pollutant emerge and incentives are created for the relevant agents to reduce emissions and sell the associated rights to other agents who are willing to pay prices which compensate for the associated costs/reductions in profits. In theory, the price mechanism leads to a socially optimal allocation of pollution rights where the difference of social gains and social costs is maximised.

Environment
Surroundings in which an organisation operates, including air, water, land, natural resources, flora, fauna, humans, and their interrelation. (ISO 14001, 2004).

Essential requirements
Requirements that represent the core of European Union law around which an effective policy has been developed in matters of safety, health and other measures for those areas covered by the 'New Approach Directives' (CEN/BOSS Glossary: http://www.cenorm.be/BOSS/glossary.asp).

ETSI
The European Telecommunications Standards Institute was founded in 1988 by the European Conference of Postal and Telecommunications Administrations on the initiative of the European Community. It is headquartered in Sophia Antipolis (France). ETSI prepares European standards in telecommunication and related fields.

European Community (EC)
The European Community was established by the Treaty establishing the European Economic Community 25 March 1957 in Rome. It was aimed at the 'harmonious development of economic activities', a 'continuous and balanced expansion' and 'increased stability'. To this end a common (or single) market

is to be created. The common market is supplemented by a monetary union ('Eurozone') of 16 member states. The EC constitutes the most important pillar of the EU.

European Court of Justice
The European Court of Justice is the highest court in the EU and ensures that Community law is equally applied in each member state. Each of the 27 member states provides one judge at present while 13 judges suffice to constitute the 'Grand Chamber'. The Court is supported by eight 'advocates-general' who publicly and impartially present their verdicts on the cases in hand. In order to cope with thousands of legal cases a 'Court of First Instance' was installed in 1989. For further information see the ECJ website (http://curia.europa.eu/jcms/jcms/j_6/). The Court of Justice usually steps into action if:

- Community law is interpreted and applied in contrasting ways within different member states,
- A member state fails to fulfil its obligations.
- A specific EU law is considered to be illegal by some member states, the Council or the Commission.
- The Parliament, the Council or the Commission fails to make certain decisions which they are obliged to make.

European Directive
Prepared by the European Parliament, the Council and the Commission, 'a directive shall be binding, as to the result to be achieved, upon each Member State to which it is addressed, but shall leave to the national authorities the choice of form and methods' (Article 249 (ex Article 189) of the EC Treaty).

European Standard
Standard adopted by CEN/CENELEC and carrying with it an obligation for implementation as an identical national standard and for withdrawal of conflicting national standards. The term 'harmonised standard' is used in the context of the New Approach directives (see CEN/CENELEC Internal Regulations - Part 2: Common Rules for Standards Work (2008), http://www.cen.eu/BOSS/supporting/reference+documents/cen-cenelec+internal+regulations+-+part+2/2+-+definitions.asp#2_25).

European standards bodies
The formal European standards bodies which are acknowledged by the EU and play a pivotal role in the European standardisation policy, i.e.:
- European Committee for Standardization (CEN)
- European Committee for Electrotechnical Standardization (CENELEC)
- European Telecommunications Standards Institute (ETSI).

European Union
The European Union is a family of European countries with similar basic values, political systems and common goals. It provides a framework for economic and political cooperation. Its 27 member states have transferred substantial elements of national sovereignty to the EU. The main goals of the EU are prosperity, freedom and the creation of a European identity.

Free riding
Free riding involves economic actors who - measured by their willingness to pay - only participate to an insufficient degree in the financing of public goods but still use these goods to their full extent..

Focus strategy
A company concentrates on a specific market/market niche where it performs exceptionally well. A focus strategy may be combined with cost leadership strategy of a differentiation strategy, as well as the instruments of standardisation or 'non-standardisation', e.g. idiosyncratic production processes or unique product features.

Game theory
Game theory is a microeconomic sub-discipline that deals with the behaviour of rational agents in situations where interests are more or less conflicting (i.e. games in the broadest sense): Given a certain set of rules, some agents (players) choose strategies from given sets of strategies, interact accordingly and eventually receive pay-offs associated with their strategy choices. The goal of game-theory analysis is to find solutions to, or more specifically, equilibria in game-like situations, i.e. strategy choices which can be expected to be made by rational agents in such or comparable situations. One prominent solution concept is the Nash equilibrium while a prominent and much-discussed game is the prisoner's dilemma. Game theory is widely applied not only in economics but also in other social sciences and in conflict resolution research.

Ghost products
Ghost products, or vapourware in the case of software, are announced for strategic reasons but never actually come into existence or enter the market.

Globalisation
The term 'globalisation' denotes the increased economic exchange and integration on the world scale and the associated socioeconomic consequences.

Harmonised standard, harmonised document
Technical specification adopted by European Standards Organizations, developed under a mandate given by the European Commission and/or European Free Trade Association in support of essential requirements of a New Approach Directive. NOTE: This concept is different from the concept of 'Harmonised

standard' used by ISO/IEC and by the 'Low Voltage Directive'. (CEN/BOSS Glossary: http://www.cenorm.be/BOSS/glossary.asp#N)

Hierarchy standard
Hierarchy standards are imposed in a top-down fashion by a high-level hierarchical entity in a respective institutional/organisational context such as companies or government agencies. Hierarchy standards are binding within their given domain.

High levels of protection
In their New Approach Directives, EU organs ask for high levels of protection in those fields where regulatory intervention takes place, i.e. in the domains of quality, safety, consumer protection and environmental protection (see the Council Resolution of 7 May 1985 on a new approach to technical harmonisation and standards). This basically legitimate goal has, as some scholars argue, the side effect of imposing technical barriers to trade, especially for developing countries.

IBM
International Business Machines Corporation, abbreviated IBM and nicknamed 'Big Blue' (for its official corporate colour), is a multinational computer technology and IT consulting corporation headquartered in Armonk, New York, United States. The company is one of the few information technology companies with a continuous history dating back to the 19th century. IBM manufactures and sells computer hardware and software, and offers infrastructure services, hosting services, and consulting services in areas ranging from mainframe computers to nanotechnology (source: Wikipedia, http://en.wikipedia.org/wiki).

ICT
Information & communication technologies.

ICT area, ICT companies, ICT industry, ICT sector, ICT branch
Largely synonymous terms for the entirety of all firms active in the field of information and communications technology.

ICT standardisation
All standardisation activities carried out in the field of information and communications technology.

IEC
The International Electrotechnical Commission (IEC) was founded in 1906, is headquartered in Geneva and prepares international standards in the field of electrotechnology.

Implementation
Implementation is the realisation of an application, or execution of a plan, idea, model, design, specification, standard, algorithm, or policy.
In computer science, an implementation is a realisation of a technical specification or algorithm as a program, software component, or other computer system. Many implementations may exist for a given specification or standard. For example, web browsers contain implementations of specifications recommended by the World Wide Web Consortium, and software development tools contain implementations of programming languages.
In the IT Industry, implementation refers to the post-sales process of guiding a client from purchase to use of the software or hardware that was purchased. This includes requirements analysis, scope analysis, customisations, systems integrations, user policies, user training and delivery. These steps are often overseen by a project manager using project management methodologies set forth in the project management body of knowledge. Software implementations involve several professions that are relatively new to the knowledge based economy such as business analysts, technical analysts, solutions architects and project managers.
In political science, implementation refers to the carrying out of public policy. Legislatures pass laws that are then carried out by public servants working in bureaucratic agencies. This process consists of rule-making, rule-administration and rule-adjudication. Factors impacting implementation include the legislative intent, the administrative capacity of the implementing bureaucracy, interest group activity and opposition, and presidential or executive support (source: Wikipedia, http://en.wikipedia.org/wiki).

Indirect horizontal compatibility
Indirect horizontal compatibility exists when the complements of a firm's core product are also compatible with another, different core product. Indirect horizontal compatibility is established e.g. by emulators or virtual machines.

Indirect network effects
The term 'indirect network effects' denotes the phenomenon of benefits for an individual user of a certain product increasing once other parties bandwagon the design of an interrelated product. For instance, a barcode system increases with the availability of scanning equipment (Nicklas, 1997, p.195).

Indirect network externalities
Indirect network externalities are obtained when each user must join two or more components belonging to different networks to derive potential network benefits. With respect to indirect network externalities, if a consumer buys a certain product today, it does not alter the current utility of the others. However, today's buying decision has certain effects on the variety and prices of compatible components in the future. Consequently, the consumer's decision today affects his/her utility in the future. In this case, there is an incentive for

consumers to choose the most popular product in an attempt to obtain more benefits from the supply of other supplements in the future.

Industrial Revolution
The Industrial Revolution was the major technological, socioeconomic and cultural change in the late 18th and early 19th century resulting from the replacement of an economy based on manual labour to one dominated by industry and machine-based manufacture (Wikipedia: http://en.wikipedia.org/wiki/Innovation).

Inferior technology/ specification
An inferior technology or specification performs worse in one or more respects, as compared to rival technologies/specifications. Inferior technologies and specifications can nevertheless survive in the marketplace, for example because of network effects, excess inertia on the part of users, or historical events.

Information
Pattern of matter and/or energy forms which is, in a given context, observable, interpretable, and relevant to an observer (Wikipedia, http://de.wikipedia.org/wiki/Information).

Information/measurement standards
In information and measurement standards provisions are made for the classification handling, storing and retrieval of information as well as measures (e.g. the metre or the kilogram) and methods of measurement are introduced which allow for the comparison of different objects or goods.

Information asymmetry
In economics, information asymmetry occurs when one party to a transaction has more or better information than the other party. (It has also been called asymmetrical information and markets with asymmetrical information). Typically it is the seller that knows more about the product than the buyer, however, it is possible for the reverse to be true: for the buyer to know more than the seller (source: Wikipedia http://en.wikipedia.org/wiki). Information asymmetry was originally introduced by Akerlof (1970) with regard to the market for lemons. This economic concept has been modified in different areas. In the context of standards, the information asymmetry refers to a situation when buyers of certain products have less information than the sellers. If customers are not able to distinguish high-quality goods from other low-quality ones before buying, the supplier of the high-quality goods will find it difficult to sustain a price premium. In this case, he may not be able to survive if his cost exceeds that of the other competitors who sell low-quality products. The low-quality sellers will then drive high-quality suppliers out of the market by undercutting them. Consequently, the market for both the producers and the customers of high-quality products will break down, meaning a severe market failure.

Information standards
Standards help provide evaluated scientific and engineering information in the form of publications, electronic databases, terminology, and test and measurement methods for describing, quantifying, and evaluating product attributes (Tassey, 2000, p.4).

Innovation
Innovation is the implementation of a new or significantly improved idea, good, service, process or practice which is intended to be useful. Scholars who have studied innovation generally differentiate between five main types of innovation: product innovation, process innovation, organisational innovation, marketing innovation and business model innovation (Wikipedia: http://en.wikipedia.org/wiki/Industrial_revolution).

Installed base
The installed base is the fraction of the user base which has opted for a standard, specification or technology (and not its rival standard).

Integration
Creation of a super system by coupling two or more systems. For instance, economic integration of two countries implies abolition of all barriers to trade and measures such as a customs union and monetary union.

Interface
Interfaces are points at which adjacent system elements are linked to each other or the overall system is linked to the outside world (Dreger 1982, 155). Interfaces are neither structural elements nor activities, but merely the air gap or space between two elements (Dreger 1982, 155 f.).

Internal Market Single Market, Common Market.
An internal market is created by the abolition of all internal barriers of trade. This includes the creation of a customs union, the removal of all non-tariff barriers to trade and the freedom of movement for goods, services, capital and labour.

International standard
The standard recognised by an international agreement to serve internationally as the basis for assigning values to other standards of quantity concerned.

Intellectual property rights (IPR)
These include patents, copyrights, trademarks and trade secrets, of which the patents and copyrights are often associated with standards. Thus when standards incorporate technologies that are to be protected, IPR provide a tool for controlling the use of standards.

Interested party
Individual or group concerned with or affected by the environmental performance of an organisation (ISO 14001, 2004).

IPR policies/IPR rules
In standards preparation reference is increasingly being made to proprietary specifications and technologies owned by specific firms. Such holders of intellectual property rights (IPR) have significant bargaining power in standardisation processes and may be unwilling to share their expertise with other firms and potential rivals. To encourage such firms to participate and to avoid the threat of 'patent trolling', most standards developing organisations have devised IPR policies which grant license fees to the owner of a bottleneck technology, e.g. according to the 'RAND principle' (RAND: Reasonable and Non Discriminatory Licensing) or rule out any license payments.

International standard
A standard that is adopted by an international standardising/standards organisation and made available to the public (ISO/IEC Guide 2:2004, definition 3.2.1.1).

ISO (International Organization for Standardization)
'ISO, International Organization for Standardization, is a network of the national standards institutes of 162 countries, on the basis of one member per country, with its Central Secretariat in Geneva, Switzerland, which coordinates the system.' See ISO (2009): About ISO. http://www.iso.org/iso/about.htm.

Learning cost
This cost is a component of the switching cost. It is incurred when customers need to be familiar with and to learn how to use the new system/products that they have decided to switch to.

Learning curve, learning effects
The term learning effects denotes the phenomenon that production processes and the associated activities can be performed better, faster and more cost-efficiently, the more often these activities are repeated. Learning effects allow for economies of scale, i.e. an output-dependent decrease in unit cost. A learning curve is merely a graphical representation of this interrelation.

Leverage effect
In the context of de facto standardisation, a leverage effect exists in the sense that in the presence of strong network effects only a small lead-in market share suffices to win over and dominate the whole market.

License
A contractual agreement giving written permission to another party to use an intellectual property right (Clarke, 2004).

Life cycle
Consecutive and inter-linked stages of a product (KEY NEW) system, from raw material (KEY OLD) acquisition or generation of natural resources to the final disposal (KEY OLD). Source: ISO14, http://iso14.vintara.com/information/over_statistics.html.

Lock-in
The term 'lock-in' denotes the tendency for users to stick with one standard even when the technology has become old-fashioned or inferior, because of the cost of conversion to a new standard (Arthur, 1988).

Mark
A design, symbol, logo, or other mark used to establish the identity and image of a product or service.

Market
A market is a specific institutional arrangement consisting of rules and conventions that make possible a large number of voluntary transfers of property rights on a regular basis, these reversible transfers being implemented and enforced through a specific mechanism of regulation, the competitive price system (Ménard, C. (1995): Markets as institutions or institutions as markets? Disentangling some fundamental concepts. Journal of Economic Behavior and Organization, 23, p.170).

Market attributes
Market attributes are the basic characteristics that a market exhibits. This encompasses the given market form (e.g. monopoly, oligopoly, perfect competition), the distribution of market power, fluctuations and market shares, the revenue a market generates, market growth the legal framework, (the frequency of) innovation cycles and structural/technological specifics such as network effects.

Market failure
This term is applied to situations where a market only inefficiently allocates resources, prices significantly differ from competitive price levels, and persistent supply-demand gaps exist. Reasons for market failures are deviations from complete competition, e.g. monopolistic market structures, information asymmetries, or externalities. Standards can help to alleviate market insufficiencies, e.g. in the case of Akerlof's 'Market for Lemons'.

Market forces (according to Porter)
According to Porter, the relevant market forces are: substitute products, threat of the entry of new competitors, bargaining power of suppliers, bargaining power of customers, competitive rivalry.

Market power
In economics, market power (sometimes called monopoly power) is a market failure which occurs when one or more of the participants have the ability to influence the price or other outcomes in some general or specialised market. The most commonly discussed form of market power is that of a monopoly, but other forms exist such as monopsony and more moderate versions of these two extremes. Market participants that have market power are sometimes referred to as 'price makers'", while those without are sometimes called 'price takers'" (source: http://en.wikipedia.org/wiki).

Market entry barriers, barriers to market entry, market access barriers
Barriers that make it difficult for potential competitors to gain access to a market. Market-access barriers may for example have a legal origin, as is the case with patents.

Marshall Plan
Named after United States Secretary of State George Marshall, the European Recovery Program ('Marshall Plan') was the main US contribution to the reconstruction of Europe after World War II. It started in 1947 and was largely received by western European countries because Stalin declined the invitation sent to eastern European countries to take part.

Mass customisation
Mass customisation denotes the combination of advanced forms of mass production and customisation. The resultant product is both cost-efficient but at the same time tailored to the specific needs/preferences of a customer.

Mass production
A production system characterised by mechanisation, high wages, low prices, and large-volume output. (source: http://economics.about.com/library/glossary) This usually refers to factory processes or metalworking, not to textiles or agriculture. The term came into use in the 1920s and referred to production approaches analogous to those of the Ford Motor Company in the US. In economics, economies of scale make mass production possible.

Measurement standard
Standard that provides a method to be used to check whether the criteria required by a standard have been met.

Microcomputer
Microcomputers are relatively small computers (as compared to mainframe computers) which rely on microprocessors and can be operated by a single person. The term is more or less outdated.

Microeconomic theory
Microeconomic theory denotes the branch of economic theory which investigates the behaviour of single economic entities (firms, consumers or the government) in specific socioeconomic settings, especially markets. Economic entities are usually assumed to behave rationally and to maximise profits (in the case of firms) or utility (consumers). Microeconomic theory encompasses various sub-disciplines such as game theory, equilibrium theory, social choice theory of welfare economics.

Microsoft
Microsoft Corporation is a multinational computer technology corporation based in the United States that develops, manufactures, licenses, and supports a wide range of software products for computing devices. The company is headquartered in Redmond, Washington, USA, and its most profitable products are the Microsoft Windows operating system and the Microsoft Office suite of productivity software (source: http://en.wikipedia.org/wiki).

Minimum quality standards/safety standards
These standards are developed to specify acceptable product or service performance along one or more dimensions such as functional levels, performance variation, service lifetime, efficiency, safety, and environmental impact (Tassey, 2000, p.4).

Mix and match
The term 'mix and match' denotes the scope for users to combine components/ subsystems of different firms and functionalities via standardised interfaces to create a system which exactly meets user demands.

Modularisation
Modularisation implies the functional decomposition of a technical system/ product (or a family of technical systems/products) into 'subfunctionalities' and associated subsystems/subproducts. These subsystems/subproducts are called 'modules' and may be combined via interfaces to recreate some specific functionalities or the overall functionality of the original system/product.

Monopoly
A monopoly is a market form where buyers face only one seller. Monopolies are usually regarded as undesirable because monopolists can exploit consumers, e.g. by setting prices above competitive levels. Natural monopolies may exist,

however, when economies of scale are present (these are maximised in a monopoly) or in network provision.

Nash equilibrium
In game theory, a Nash equilibrium exists if each player has - given the strategy choices of all other players - no incentive to deviate from his chosen strategy, as such behaviour does not yield any higher payoff.

National standard
A standard that was passed by a national standards body and that is valid in the respective country.

National standardisation system
A national standardisation system encompasses all national bodies and organisations active in standardisation, the interrelations among those and their interrelations with their environment.

Negative network effects
Negative network effects occur when the utility of an individual network participant decreases with growing size of a network.

Network
A network consists of entities (nodes) which are interconnected and interrelated via (standardised) interfaces and exchange matter, energy and information.

Network effects
'The benefit that a consumer derives from the use of a good often is an increasing function of the number of other consumers purchasing compatible items... we call these positive consumption benefits network externalities' (Katz, M.L./ Shapiro, C. (1986): Product Compatibility Choice in a Market with Technological Progress. In: Oxford Economic Papers, Vol. 38, Suppl., p.146).

Network externality
Network externalities causes a good or service to have a value to a potential customer dependent on the number of customers already owning that good or using that service. One consequence of a network externality is that the purchase of a good by one individual indirectly benefits others who own the same good. For example by purchasing a telephone; a person makes other telephones more useful. In the context of standardisation, a network externality refers to the benefit of having common standards as it allows the current users to benefit from the size of the network (source: Wikipedia, http://en.wikipedia.org/ wiki).

New Approach
The New Approach to technical harmonisation and standards was introduced in the mid-1980s by the European Community and provides the core element of the European standardisation policy (which is directed at the completion of the European Single Market). Basically, in an effort to harmonise the standards repositories of the member states and to reduce the associated technical barriers to trade, EU organs define 'essential requirements' in European Directives. These Directives are legally binding and lay down provisions on a rather abstract level in fields, such as product quality, consumer protection, safety, environmental protection, where public interest is affected. On the basis of those Directives, European Standards Bodies prepare European Standards which member states are obliged to adopt in their standards repositories. The New Approach proved to be fairly successful and serves as a regulatory role model for supranational integration.

New Approach Directive
European Directive which defines legislative harmonisation in a sector where barriers to trade are created by divergent national regulations concerning the health or safety of citizens or consumer or environmental protection. New Approach Directives only lay down the 'essential requirements, conformity with which will entitle a product to free movement within the Community' (CEN/BOSS Glossary: http://www.cenorm.be/BOSS/glossary.asp). Presently, 22 New Approach Directives exist in fields as diverse as the safety of toys, medical devices, machinery safety, low voltage equipment and electromagnetic compatibility (see New Approach Standardisation in the Internal Market: http://www.newapproach.org/Directives/DirectiveList.asp).

Non-governmental organisation (NGO)
NGOs operate independently of governments, usually on a non-profit basis. They aim to improve social, cultural, legal, and environmental deficiencies (Wikipedia: http://en.wikipedia.org/wiki/Ngo).

Non-tariff barriers to trade
All barriers to trade other than tariffs are called non-tariff barriers to trade. This term especially refers to national laws, regulations and indeed standards repositories which hamper the free movement of goods, capital and services.

OEM (Original Equipment Manufacturer)
An original equipment manufacturer sells its products to other firms which in turn sell these products under their brand name.

Official Journal of the European Commission
The Official Journal of the European Commission is an official publication of the institutions of the European Union which is published daily. The 'L series' contains EU legislation (Regulations; Directives, etc.), while the 'C series' contains EU information and notices (e.g. summaries of judgments of the Court of Justice or minutes of parliamentary meetings. CEN/BOSS Glossary: http://www.cenorm.be/BOSS/glossary.asp#N)

Office Open XML (OOXML)
Originally developed by Microsoft, Office Open XML (OOXML, XML: Extensible Markup Language) is a file format for the representation of spreadsheets, charts, presentations and text documents. Microsoft submitted its OOXML specification to ECMA International where it became an ECMA standard (ECMA-376). This standard was then submitted to the Joint Technical Committee 1 of ISO and IEC to undergo fast-tracking in order to become an ISO/IEC standard in 2008 (ISO/IEC 29500:2008). This, however, did not proceed in a perfectly smooth manner, and Microsoft was criticised from various sides for abusing and manipulating the ISO/IEC standardisation process (an accusation to which Microsoft admits to some degree; see e.g. http://news.zdnet.co.uk/software/0,1000000121,39288959,00.htm for details) and for submitting a poor (if not bad) draft specification.

Operating system
An operating system (OS) is software (and a software layer) which provides an interface between a computer (i.e. its hardware) and the application software which runs on it and the user. It usually includes the kernel, which carries out the basic tasks (e.g. addressing the central processing unit or the memory), and additional useful if not indispensible components of an OS such as a boot manager or hardware drivers.

Pareto efficiency
Pareto efficiency, a fundamental welfare criterion in economics, exists when one agent's utility can only be increased by decreasing the other agents' utility.

Peer-to-peer standards
Peer-to-peer standards are compatibility standards which are a prerequisite for the set-up of peer-to-peer networks in which hierarchically and functionally equivalent nodes (e.g. PCs) share resources.

Patent
A patent is a set of exclusive rights granted by a state (national government) to an inventor or his/her assignee for a limited period of time in exchange for the public disclosure of an invention (source: Wikipedia, http://en.wikipedia.org/wiki/Patent).

Patent trolling
The term 'patent trolling' denotes a firm's scheme to acquire patents which have no practical value in the first place but are instead used to sue and claim damages from other firms which have apparently infringed on those patents.

Patent trolling not only hits firms but can also have a highly detrimental effect on standards preparation because some technologies/specifications to which reference is made in standards may be patented and as such susceptible to patent infringement suits. To avoid such pitfalls, standards bodies have devised appropriate intellectual property rights policies.

Penetration pricing
Penetration pricing denotes an aggressive price policy which aims at the swift build-up of an installed base. Penetration pricing may take the form of price-setting below costs, zero pricing or even negative prices.

Perfect competition
Perfect competition is a theoretical reference point in economic theory. Perfect competition occurs if there are many buyers and sellers, no market entry/exit barriers, no transaction costs, rational behaviour (profit/utility maximisation), perfect information, and homogenous products (Wikipedia, http://en.wikipedia.org/wiki/Perfect_competition). In theory, perfect competition induces a social state in which resources are efficiently allocated, the market is cleared (demand equals supply) and firms have no power to set prices above competitive levels. In reality, only approximations to perfect competition can be observed.

Personal computer (PC)
In the strict sense, the term personal computer denotes a microcomputer which is constructed according to the IBM PC architecture. In the broader sense, the term denotes every computer which may be used, carried and operated by a single person..

Primary property rights
Primary property rights are relatively 'strong' property rights such as patents and copyrights, as opposed to 'weaker' secondary and tertiary property rights. With regard to the product life cycle, primary property rights are frequently associated with the introduction stage when a new product/technology and the corresponding profits are especially vulnerable to imitation.

Processor
A processor (or central processing unit) is a core component of a computer and consists of logical circuits and executes program code.

Public good
Two attributes constitute a (pure) public good: (1) non- excludability: no one can be excluded from consuming such a good; and (2) non-rivalry: one agent's consumption of the good has no (adverse) effect on other agents' consumption. Typical examples for public goods are peace or dikes; although public goods in the purest sense do not seem to exist (i.e. none has been identified yet). Public goods are usually provided by the state. Private agents (i.e. firms) have no incentive to do so, as this would only incur the associated costs while the corresponding benefits cannot be appropriated (because of the non- excludability problem, firms cannot enforce property rights.)

Quality standards
A quality standard defines minimum requirements that a product, process or activity has to meet in order to comply with the standard. In this case, the product, process or activity can be certified accordingly, which in turn signals a minimum quality to users.

Publicly Available Specifications (PAS)
Umbrella term for standards which prepared and published by consortia and fora (and occasionally by acknowledged/formal standards bodies to shorten time to market) and which are open to the public/all interested parties (to be distinguished from formal standards).

Reduction of variety/variety reduction
Variety reduction is one of the most immediate emanations of standardisation and a key instrument of rationalisation in production. Variety reduction results in a smaller product range and a reduced number of different parts used in production, thus enabling better plant utilisation, e.g. in the form of extended machine times/shorter changeover times, increased batch sizes and easier/more cost-effective warehousing - effects which all enable 'economies of scale'.

Reference standards
A reference standard provides a measure (and methods of measurement) which can be used for measurement and the comparison of objects in a reproducible fashion. Typical reference standards are the metre or the kilogram which allow for the reproduction of scientific findings and enhanced economic exchange.

Research and development (R&D)
The phrase research and development (also R and D or, more often, R&D), according to the Organisation for Economic Co-operation and Development, refers to 'creative work undertaken on a systematic basis in order to increase the stock of knowledge, including knowledge of man, culture and society, and the use of this stock of knowledge to devise new applications' (source: Wikipedia, http://en.wikipedia.org/wiki).

Regulation
Usually performed by the government or government agencies, the term 'regulation' denotes the activity of influencing or directing human behaviour in a society according to some set of socioeconomic goals. According to these goals a set of rules and incentives is introduced to encourage/prescribe favourable behaviour patterns and to discouraged/forbid detrimental behaviour patterns.

Safety standards
A safety standard defines the minimum safety requirements that a product, process or activity has to meet in order to comply with the standard. In this case, the product, process or activity can be certified accordingly and expected to perform within certain safety margins, in line with the state of the art.

Secondary property rights
Secondary property rights such as brands or proprietary names are 'weaker' than primary property rights such as patents, but 'stronger' than tertiary property rights. With regard to the product life cycle, secondary property rights are frequently associated with the growth stage of a product.

Self-fulfilling prophecy
A self-fulfilling prophecy occurs when some agents firmly believe in a certain outcome of particular events and (intentionally) act accordingly, thus increasing the probability of and paving the way for the expected outcome.

Specifications
A specification is an explicit set of requirements to be satisfied by a material, product, or service. Should a material, product or service fail to meet one or more of the applicable specifications, it may be referred to as being out of specification; the abbreviation OOS may also be used. A technical specification may be developed privately, for example by a corporation, a regulatory body, the military, etc. It is usually under the umbrella of a quality management system. Specifications can also be developed by standards organisations which often have more diverse input and usually develop voluntary standards: these might become mandatory if adopted by a government, business contract, etc. (source: Wikipedia, http://en.wikipedia.org/wiki).

Standard
Document, established by consensus and approved by a recognised body, that provides, for common and repeated use, rules, guidelines or characteristics for activities or their results, aimed at achieving the optimum degree of order in a given context (ISO/IEC, 1969b). Unfortunately, not all standards fit into this definition: not all standards are consensus-based or approved by a recognised body and standards may have a format other than a document, e.g. software, as in the case of Windows. De Vries (1997) has therefore developed another definition: a standard is an approved specification of a limited set of solutions to actual or potential matching problems, prepared for the benefits of the party or parties involved, balancing their needs, and intended and expected to be used repeatedly or continuously, during a certain period, by a substantial number of the parties for whom they are meant. See Unit 1, Chapter 2. Standards can be de facto, which means they are followed for convenience, or de jure, which means they are used because of (more or less) legally binding contracts and documents.

Standards Body
The term 'standards body' denotes every entity which develops (or coordinates the development of) standards and maintains standards and standards repositories. The term is in the first place used to denote formal (or acknowledged) national, regional and international standards bodies but may also apply in the case of standards-developing organisations such as consortia or fora.

Standards Committees
Standards Committees (or technical committees) form an organisational core element in standards developing organisations. In formal standards bodies, for example, technical committees consist of experts who voluntarily participate in standards preparation. Technical committees feature a chairman, who functions in the first place as a mediator, and are supported by a secretariat. The decision-making mechanism of choice is the consensus principle, with qualified majority voting being only a last resort. In SDOs, (technical) committees form an organisational core element. In formal standards bodies, for example, technical committees consist of experts who voluntarily participate in standards preparation. Technical committees have a chairman, who functions as a mediator, and are supported by a secretary. The decision-making mechanism of choice is the consensus principle, with qualified majority voting being only a last resort.

Standardisation
Activity of establishing, with regard to actual or potential problems, provisions for common and repeated use, aimed at the achievement of an optimum degree of order in a given context. (ISO/IEC Guide 2:2004). Standardisation concerns establishing and recording a limited set of solutions to actual or potential matching problems directed at benefits for the party or parties involved and intending and expecting that these solutions will be repeatedly or continuously used during a certain period by a substantial number of the parties for whom they are meant. A matching problem should be understood as a problem of interrelated entities that do not harmonise with each other; solving it means determining one or more features of entities in such a way that they harmonise with one another or of determining one or more features of an entity because of its relation with other entities (de Vries, 1997).

Standardisation process
A standards process is a sequence of events and actions by the relevant agents under the domain of a standards body which eventually leads to the completion and publication of a standard. Despite their different working fields and geographical domains, standardisation processes exhibit many institutional similarities across the different standards bodies. Standards preparation is not only carried out according to a number of basic principles ('due process', 'basic principles of standardisation'), but also involves a sequence of similar stages. At ISO, for example, a standard goes through the proposal stage, the preparatory

stage, the committee stage, the enquiry stage, the approval stage and the publication stage (see ISO, http://www.iso.org/iso/standards_development/processes_and_procedures/stages_description.htm). This sequence of 'production stages' is characteristic for many standards bodies.

Standardisation strategies
A standardisation strategy is the plan of an entity (firm, state or region) on how to handle its standardisation issues in the medium or long term, especially with regard to the standardisation strategies of other entities. Standardisation strategies may refer to in-company standardisation, to involvement and behaviour in standardisation processes, e.g. in formal standardisation or consortia, or to market-oriented strategies (de facto standardisation).

Standardisation system
This refers to the entirety of all SDOs, i.e. formal standards bodies, consortia, fora, government agencies and other organisations, in a given geographical domain (national, regional, international) that are active in standards preparation and the interrelations between these organisations.

Standards-setting mechanism
The term 'standards-setting mechanism' denotes a set of institutional rules that transform certain inputs - knowledge and preferences via the design of a standard - into certain outputs - standards and other normative documents. The holders of the relevant inputs are the actors who take part in a standardisation process.

State of the art, acknowledged rules of technology
State of the art denotes the best possible solution to a problem at a given point of time and a given state of scientific knowledge. A basic principle of standards preparation is usually to adhere to the state of the art.

Stochastics
Stochastics is an umbrella term which denotes the science of non-deterministic events and processes and encompasses the disciplines of probability theory and statistics.

Subsystem
A subsystem is a subset of a system (subset of elements and interrelations) which itself forms a system.

Supranational organisation
A supranational organisation is an organisation which consists of members of different national origins while its scope of activities and aims reach beyond

the national realm. The EU, for example, is a supranational organisation with European states as members and governmental powers.

Switching costs
These are costs incurred in changing (switching) from an established technology to a superior technology, which include the direct cost of purchasing the product with new technology as well as the indirect cost (opportunity cost) of learning how to use the new technology.

System architecture
A system architecture is the conceptual design that defines the structure and/or behaviour of a system (see Wikipedia, http://en.wikipedia.org/wiki/Systems_architecture).

Tertiary property rights
Tertiary property rights like standards are the weakest form of property rights, as compared with primary and secondary property rights. With regard to the product life cycle, tertiary property rights are frequently associated with the mature stage of a product.

Technical barriers to trade (TBT)
Any standard or technical regulation, or a procedure used in a way to impede international trade rather than for the purposes of achieving a legitimate objective. Technical regulations and product standards may vary from country to country. Having many different regulations and standards makes life difficult for producers and exporters. If regulations are set arbitrarily, they could be used as an excuse for protectionism. The Agreement on Technical Barriers to Trade tries to ensure that regulations, standards, testing and certification procedures do not create unnecessary obstacles.

Technical harmonisation
This term refers to the approximation of national technical laws and regulations and especially of standardisation repositories in order to create a genuine internal market.

Technical specification
In a general sense the term 'technical specification' denotes every normative document or technology which has the potential to become a standard, be it a formal standard, a consortium standard or a de facto standard. In its stricter sense, the term 'technical specification' refers to deliverables that standards bodies such as CEN and ISO have introduced to reduce time to market or to publish documents on which formal consensus has not yet been reached. See e.g. CEN, http://www.cen.eu/BOSS/production/production+processes+-+index/technical+specifications/technical+specifications.asp and http://www.iso.org/

iso/standards_development/processes_and_procedures/deliverables/iso_ts_deliverable.htm for details on these deliverables.

Technical standard
Any standard that is technical by virtue of its scope.

Third party
A third party is an independent certifying body which audits and grants a certificate to a vendor or producer stating that its products, processes or procedures accord to a set of relevant standards.

Transaction costs
Transaction costs are those costs which accompany economic exchange. Transaction costs may take the form of search and information costs (finding a potential transaction partner), bargaining costs (negotiating and designing the related contract), and policing and enforcing costs (which may be incurred when a contract is breached). For example, quality standards reduce transaction costs by lowering uncertainties on the part of consumers about the characteristics of specific products and thus increasing their willingness to acquire a certain product.

Undated direct reference method
In the undated direct reference method only the number and title of the standard are quoted in laws or legal texts. The advantage is that a legal text need not be modified as soon as a new version of a standard is published. The disadvantage is, however, that a legal text and the referred standard are not as stringently related as under the dated direct reference method and standards setters gain some influence on the wording/purpose of a legal text.

Utility
An economic term referring to the total satisfaction received from consuming a good or service. A consumer's utility is hard to measure. However, we can determine it indirectly with consumer behaviour theories, which assume that consumers will strive to maximise their utility. Utility is a concept that was introduced by Daniel Bernoulli. He believed that for the usual person, utility increased with wealth but at a decreasing rate (source: Investopedia, http://www.investopedia.com).

Vapourware
See 'ghost products'.

Variety-reducing standards
Variety-reducing standards slim down the product range and reduce the number of parts and components used in production. They are aimed at increasing efficiency, achieving economies of scale and reducing complexity.

Welfare
The term welfare denotes the well-being in a society, as is primarily expressed in economic terms such as (national) income or income distribution. Recently, non-economic, non-monetary factors such as happiness have increasingly been included in welfare assessment.

Welfare criterion
A welfare criterion is a criterion by which the well-being in a society can be measured and different social states can be compared. Usually, an assessment of welfare takes efficiency aspects as well as distributional aspects into account. Prominent welfare criteria are Pareto efficiency or social welfare functions such as the Bergson-Samuelson social welfare function or the total income of a society. An 'optimal' welfare criterion does not exist, however, i.e. different criteria exhibit different weaknesses and shortcomings and do not meet a number of plausible conditions (see Arrow's 'impossibility theorem').

World Wide Web Consortium (W3C)
Founded in 1994 by Tim Berners-Lee, the inventor of the World Wide Web, the World Wide Web Consortium (W3C) is the leading organisation for the development of Web standards. In May 2009, the W3C had nearly 400 members.

10 Key questions

- Which classes of standards can be distinguished according to their origin/the way they are created?
- Which types of standards can be distinguished with regard to their attributes/technical purpose?
- What are the economic benefits of standardisation?
- What forms of compatibility exist?
- What are network effects?
- Which strategic settings are conceivable in markets where two firms decide on the compatibility of their technologies?
- Which strategic instruments may be applied by firms in standards wars/on markets where network effects are present?
- Which market dynamics may occur in the presence of network effects?
- What is the role of intellectual property rights in standardisation?
- What forms of strategic behaviour may occur in standardisation processes?



Chandana Perera

Abstract

This unit deals with several issues related to standardization and innovation. Chapter 2 discusses how standards hinder and stimulate innovation.
Introducing the dynamics of innovation Chapter 3 of this unit explains how dominant design, which is the accepted standard design of the product, is established in the innovation process. Standards are involved throughout the innovation process in areas such as communication, testing and R&D process management. The relevant issues are explored further in Chapter 4. Standards play a significant role in market acceptance of the product. Different types of standards are important for the market acceptance and establishment of dominant design. A detail explanation of these standards is given in Chapter 5. Environmental standards are one of the important types of standard that influence innovation. Chapter 6 discusses how environmental standards influence innovation and how environmental standards can be imposed without hindering innovation. Innovation, intellectual property and standards are interrelated with each other. Understanding this relation is very important and this aspect is discussed in Chapter 7. Concluding remarks are given in Chapter 8.

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1 Preface

Standardization deals with keeping things the same, whereas innovation concerns development of new things. Consequently, standardization and innovation give the impression of being opposites, and standardization may be accused of hindering innovation. However, some studies show positive correlations between standardization and innovation. This situation raises the question of whether standardization hampers or encourages innovation.
When examining the dynamics of innovation, it becomes evident that the standard for the product design, which is known as the dominant design, is established in the innovation process. It is important to understand how the dominant design is established and the factors that influence it. Throughout the innovation process, it is possible to observe the different roles of standards. Gaining such knowledge is important for the success of innovation. There are different types of standards which are crucial for market acceptance.

Traditional view of standardization and innovation

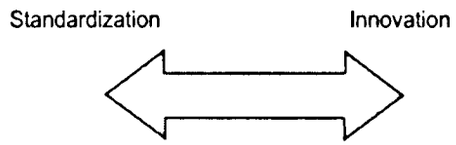


Figure: Traditional view of standardization and innovation (© Chandana Perera)

In developing new products, an understanding of these standards is very important for establishing the dominant design. These standards are decided by regulatory authorities, manufacturers and various market factors. A lack of understanding of these standards will result in the product being unsuccessful on the market.
Environmental standards are one of the most influential standards affecting innovation. Badly formulated environmental standards hamper innovation, while good ones stimulate innovation. Organizations should not always fight against environmental standards and, instead, look at the opportunities offered by environmental standards that enhance competitiveness.
Standards and patents are both ways of explaining a primarily technical solution. A standard is intended to be used by any party for which it is intended, but a patent is only used by the patent holder. What standards and patents have in common is the fact that they make information available to prevent a reinvention of the wheel. A company can choose between patents and standardization or a combination of both for its invention, depending on

which option is the best for achieving market success. The main aim of this unit is to provide knowledge on the relationship between standardization and innovation. Such knowledge is useful for innovators to decide how standards could be used to make innovations successful. In compiling the material for this unit, the author has used the published literature on different standardization practices and innovations.

2 The paradox of standardization and innovation

According to ISO/IEC Guide 2, standardization is the activity of establishing, with regard to actual or potential problems, provisions for common and repeated used, aimed at the achievement of the optimum degree of order in a given context. Another definition states that standardization lays down the definitive solution of a repetitive technical or organizational problem with the best technical means available at the time, and therefore is a form of technical and economic optimization limited by the time factor.
Innovation can be defined as the commercialization of all new products based upon the application of new materials and components, the introduction of new processes, the opening of new markets, and/or the introduction of new organizational forms. So, innovation is more than an invention; it is a commercialized invention.
When developing a standard solution, the intention is that this solution will be used repeatedly. Therefore, standardization provides a 'static' solution because the solution is 'frozen' over a certain period of time. During this period of 'freezing', the emergence of new solutions that solve the same problem in a better way is hindered by standardization. From this point of view, standardization definitely hinders innovation (De Vries, 2006). The following examples show how standardization hinders innovations.

Example 1: QWERTY Key Board (Source: De Vries, 2006)
A classic example for hampering innovation by standardization is the QWERTY keyboard. The QWERTY keyboard was developed in the 1870s to increase the speed of typists by reducing the occurrence of jamming. The design was based on the frequency of use of letters in the English alphabet. However, the QWERTY design no longer makes sense because mechanical constructions have been replaced by electrotechnical and electronic machines. Better keyboards with improved ergonomics have been invented that allow for more speed. However, QWERTY remains the common solution implemented everywhere since the costs of conversion are too high. The conversion costs include the costs of replacing hardware and the switching costs of training users to learn to work with the new standard. The latter is more significant. Moreover, there is a 'prisoner's dilemma': the new standard would be attractive once many others

were to use it, both typists and keyboard producers, but this applies for everyone, so everyone waits for everybody else and no-one starts. So all are 'locked-in' to the old-fashioned technology.
However, there is another side to the story. QWERTY is just the standard for the interface between user and machine. Since its introduction, the machine itself has been developed a lot, from mechanical to electronic. The standard was a prerequisite for this innovation: an improved machine without a standard keyboard would not be acceptable to the market. Moreover, the world-wide standard interface enables manufacturers (of hardware, but also of software and education) to profit from economies of scale, so inventions have more chance to become innovations - innovations that are successful in the market.

Example 2: Colour television (Source: De Vries, 2005)
European televisions have better colours than American televisions. The reason for the latter's harsh colours is that the Americans standardized the specifications for cameras, broadcasting stations, antennas and televisions in an early stage of technological development. Better systems were developed afterwards that allow for sharper contrast and better colours. It seems that the advantages of the better technology are more than the cost of conversion, but there should be a form of common agreement between the parties concerned to start this conversion, as in the QWERTY example. The initial failure of high-definition television demonstrates the difficulty of this.
Again, standardization has hampered innovation. But, again, this is only one side of the coin. Without standards, television systems are impossible: cameras, broadcasting stations, antennae and televisions have to match each other in order for the entire system to function. As long as compatibility standards remain, the cameras, broadcasting stations, antennas and televisions can be innovated; otherwise such innovations would not be possible. Moreover, the early adoption of colour television standards has strengthened the American's

The paradox of standardization and innovation

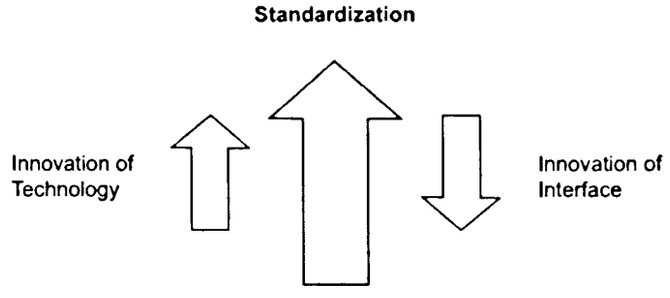


Figure: The paradox of standardisation and innovation (© Chandana Perera)

lead in developing and producing TV programmes and films. Today the United States dominate television schedules all over the world.
From the above two classic examples of standardization that have hindered innovation, it can be seen that there is another side as well: without the standard it would not have been possible to develop the invention into a market success. The standards have therefore hindered innovation of the interfaces but stimulated innovation in the technology itself, as far as this is possible without affecting the interface. In this situation, the innovation and the standard provided solutions for the same problem.
Many standards do not describe a design, but specify performance criteria for a design and in that case; innovation is not hindered by the standard.

3 Innovation dynamics and standards

3.1 Dynamics of innovation

A model developed by Abernathy and Utterback to explain the dynamics of innovation hypothesizes that the rate of major innovation for both products and processes follows a general pattern over time, and that product and process innovation share an important relationship.
The rate of product innovation in an industry or product class is highest during its formative period. This period, called the 'fluid phase', is when a lot of experimentation with product design and operational characteristics takes place among competitors. The period of fluidity, according to the model, typically gives way to a 'transitional phase', in which the rate of major product innovation declines and the rate of major process innovations increases. At this point, product variety begins to give way to a standard design that has either proven to be the best form for satisfying user needs in the marketplace, or a design that has been dictated by accepted standards, by legal or regulatory constraints. This standard design is known as the dominant design. As the form of the product rapidly becomes settled, the pace of innovation in the way it is produced quickens.
This is followed by a specific phase in which the rate of major innovation falls for both product and process. Many industries become extremely focused on cost, volume and capacity of product, and process innovation takes place in small, incremental steps. Naturally, not all industries or products pass through these tidy phases, but, over the years, the model has proven valuable in explaining the innovation pattern (Utterback, 1994).

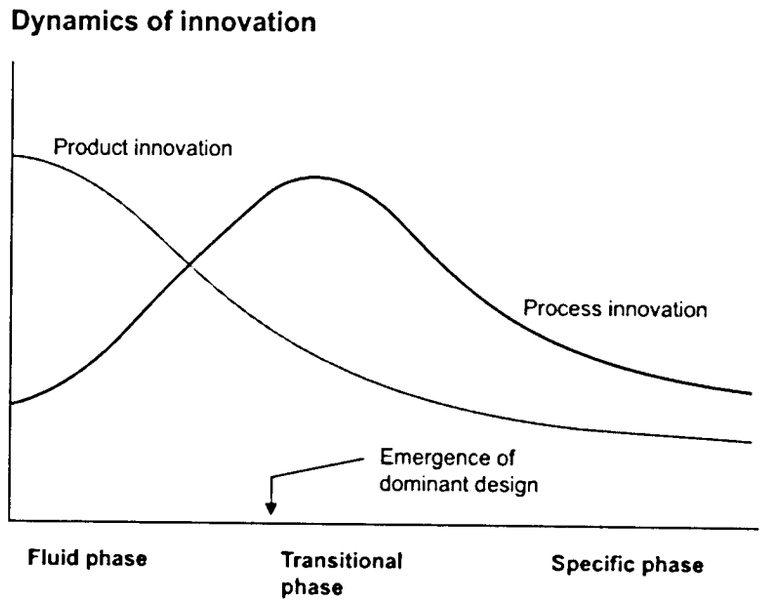


Figure: Dynamics of innovation (Source: Utterback, J.M., Mastering the Dynamics of Innovation, 1996, Harvard Business School Press, USA)

3.2 What is dominant design?

A dominant design in a product class is the one that wins the loyalty of the marketplace, the one that competitors and innovators must adhere to if they expect to command a significant market following. The dominant design usually takes the form of a new product (or set of features) created from individual technological innovations introduced independently in prior product variants.

Examples (Source: Utterback, 1994):
Looking back over the early history of the typewriter industry, we can see that the Underwood Model 5 followed this and emerged as the dominant design. The IBM PC format quickly became the dominant design in its market. It followed a pattern similar to that of the Model 5 - doing in the digital age what Underwood successfully managed in an age of mechanization. The PC, like the Model 5, offered the market little in the way of breakthrough technology, but it brought together familiar elements that had proven their value to users, a TV monitor, standard disk drive, QWERTY keyboard, the Intel 8088 chip, open architecture, and MS DOS operating system.

The emergence of a dominant design is not necessarily predetermined, but is the result of the interplay between technical and market choices at any particular time. A dominant design embodies the requirements of many classes of a particular product, even though it may not meet the needs of users of a particular class to quite the same extent as would a customized design. The dominant design is not necessarily the one that embodies the most extreme technical performance. It satisfies many in terms of the interplay of technical possibilities and market choices, instead of optimizing the needs of a few.
A dominant design drastically reduces the variety of requirements to be met by a product by embedding many of those requirements in the design itself. For example, a car had an electric starter and electric windshield wipers, a typewriter was able to produce upper and lower case letters, a personal computer had a built-in disk drive; these were unique features in models that preceded the dominant design. Today these features are implicit in designs that the market expects and that all producers find themselves compelled to emulate. They are no longer additional features of the products nor are they advertised as the advantages of a product from one manufacturer or another. They are included within the popularly accepted design (Utterback, 1994).

3.3 How does a dominant design occur?

The emergence of dominant design is a landmark event for an industry. Consequently, managers need to understand how a dominant design occurs. The emergence of a dominant design is not necessarily predetermined. It is the result of interplay between the technical and market choices. The notion of dominant design as successful evolution can be represented using Kim Clark's design hierarchies approach. A technological trajectory is established by the choice of a core technical concept at the outset. Decisions about the product, constrained by prior technical choices and by the evolution of customer choices, influence these various trajectories.
The idea of dominant design is conceptually broader than technical competition and progress. There are factors other than technology influencing the dominant design. Major factors include collateral assets, industry regulation and government intervention, strategies of individual firms, and communication between producer and users (Utterback, 1994).

Collateral assets:
A firm in possession of collateral assets such as market channels, brand image, and customer switching costs will have some advantage over its competitors in terms of enforcing its product as a dominant design. One of the examples is IBM personal computers.

Industry regulation and government intervention:
Industry regulation often has the power to impose a standard and thus define a dominant design. Today, efforts by governments around the world to define standards for high-definition television standards that will either favour or undermine the interests of their domestic producers-will certainly have an impact on dominant design in that field (Utterback, 1994).

Strategies at the firm level:
The product strategy followed by a firm relative to its competitors may determine which firm's product design becomes dominant. In establishing video cassette recorder standards, the VHS system backed by JVC won market dominance over Sony's Betamax because of the different strategies followed by these two firms. While JVC followed a humble strategy of establishing alliances first in Japan and then in Europe and the United States, Sony chose to go it alone stressing its reputation and deliberately avoiding alliances or contracts that would impinge on its vertical integration for this important new market. It was primarily JVC's strategy, and neither the technological advantages of VHS, the firm's collateral assets, nor government regulation that made VHS the dominant design. In fact, VHS was technically inferior in many ways to its Betamax rival.

Communication between producers and users:
How each firm communicates with its customers may have a significant impact on its ability to impose a dominant design. Staying close to customers makes it possible for producing firms to observe how their evolving products are actually being used, how far they satisfy customer requirements, and how design changes might close the gap between product capabilities and user requirements. Managing this producer-user interface may take the form of close ties to lead users, (source of innovations), users' associations, and industry groups (Utterback, 1994).

3.4 Dominant design, competition, and industry structure

A new product innovation by one or a few firms results in a temporary monopoly situation, high unit profit margins and prices, and sales of the innovation in those few market niches where it possesses the greatest performance advantage over competing alternatives. As demand and production grow, and as more applications are found for the innovation, many new firms enter the market with variations of the product.
The earliest period in the development of a product line or industry in which few firms participate would necessarily be a period of relatively slow technical progress and productivity advance. As larger numbers of firms enter the arena, broadening the range of experimentation and the definition of

the product technology, greater innovation is expected with a correspondingly greater progress in technology and advance in productivity.
Finally, as a few firms come to dominate the industry with superior product technology and productivity, both experimentation and progress would be expected to slow. The renewal or broadening of competition would be required for rapid progress to recur. Once the dominant design is established (i.e. standard of product is developed and contest for product innovation is settled), then competitive engagement shifts to process innovation. Firms that are unable to make the transition toward greater process innovation are unable to compete effectively and very often fail. Those that possess special resources may successfully merge with the ultimately dominant firms. Overall, the inability to change organizational structure and practices in tandem with the evolution of technology in industry is a major source of failure. Thus, there is a decline in the number of competing firms after the emergence of a dominant design (Utterback, 1994).

Dominant design and number of competing firms

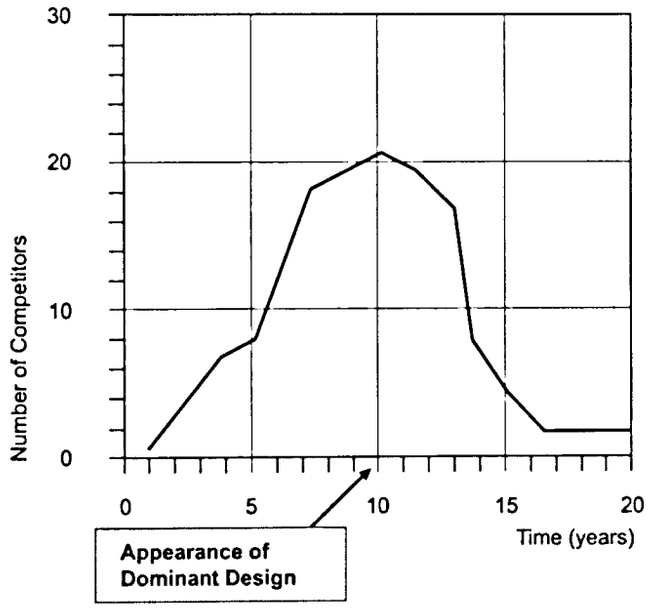


Figure: Dominant design and number of competing firms (Source: Utterback J.M, Mastering the Dynamicss of Innovation, 1996, Harvard Business School Press, USA)

Example: Typewriters revisited (Source: Utterback, 1994)
Growth in the typewriter industry was initially slow, probably because no one had mastered the typing skills needed to capture the full value of the new machine. By 1885, four new competitors had appeared, breaking Remington's monopoly, and the typewriter was gradually accepted by the public. By the early 1900s, over 30 firms had machines on the U.S. market, but until that time typewriter manufacturers were offering products with few standardized characteristics. Royal appeared in 1904, and by 1909 the number of competing firms had increased to 40. Underwood introduced its Model 5 in 1899. The visible writing of the Model 5 allowed the typist to see what he or she had actually typed as the keys struck the page. It had a tabulator, making columnar presentations much simpler and was able to cut stencils and make good copies. It won the largest share of the commercial office market. It *became the dominant design.
Only a few of the early innovative entrants survived. By 1940, only five producers had survived in the US market: Remington, Royal, Smith and Underwood each with a 20% market share and IBM with a 10% market share. Except for a variety of decorative features, there was little change in the product or the competitive situation until the introduction of the electric typewriter. It represented less of a change for the user than did the advent of the first manual machine at the turn of the century. It remained for the development of the personal computer to provide an example of similar broadening of the market.

4 Standards in the innovation process

In the process of innovation, standards play different kinds of roles. Understanding how standards affect innovation and vice-versa is very important for the success of the innovation.

4.1 Standards as a source of knowledge

Researchers develop new knowledge. However, there is no sense in constantly reinventing the wheel; instead the knowledge of predecessors should be used. Patents and standards can be used as the sources of information. Everyone can use the knowledge laid down in standards. Standards provide knowledge such as properties of materials and examples of technical solutions and methods. ICT tools can improve accessibility to standards.

Example: Piping data-base (Source: De Vries, 2005)
The Dutch-Swedish chemical company Akzo Nobel has developed a computer program for the selection of piping materials. The program determines the required material, thickness and diameter once certain variables such as working temperature, pressure, the liquid that is transported through the pipe, and the environment where the pipe is applied, have been inserted. The data are based on company standards that make use of external standards.
Only when it is really necessary will the user consult the real standard.
This document can be consulted directly on the computer screen. A list of preferred suppliers can also be added to the same system, even delivery time and conditions, when necessary. This standards-based system facilitates the development of new plants.

Standards in the innovation process

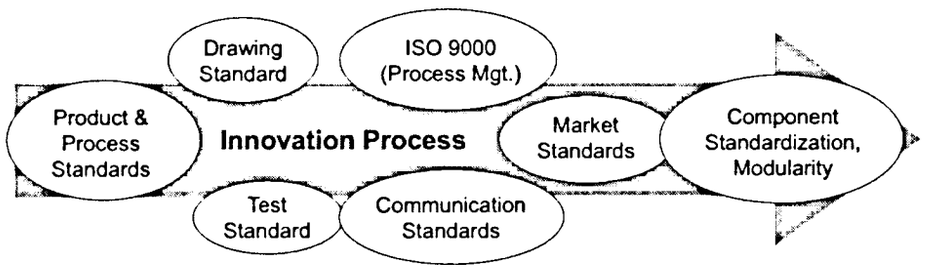


Figure: Standards in the innovation process (© Chandana Perera)

4.2 Standards for testing

Once something has been invented, its characteristics have to be tested. There are many standard test methods. These standard test methods may have an advantage over methods that the testers develop themselves.

4.3 Standards for the research environment

Researchers use standards in their development activities. Examples include standards for technical drawings and standards for laboratories and laboratory equipment.

Example: Electrotechnical symbols (Source: De Vries, 2005)
The Dutch standard NEN 5152 includes 1986 symbols for electrotechnology to be used on technical drawings. These are available in an electronic format that enables their inclusion in CAD/CAM software, so the designers will use them automatically. The use of such symbols obviates the need to reinvent them, enhances mutual understanding, avoids misunderstanding and facilitates communication.

4.4 Standards for process management

A company can use its own company standards or external standards to support the management of its (R&D and other) processes. Company standards are sometime based upon external standards such as the DIN-EN-ISO standards on quality management.

Example: ISO 9001 and innovation (Source: De Vries, 2005)
The ISO 9000 series of standards may be of help for setting up process management in the R&D department. More specifically, ISO has developed guidance for quality management in project-based organizations.

4.5 Standards for internal communication

The communication between R&D and other departments needs to be organized in order to avoid misunderstanding and confusion. Standard forms, company terminology, intranet, and product data exchange are among the options. All require standardization at the company level that may make use of external (ISO or other) standards.

4.6 Standards for market acceptance

Most products have to comply with standards before the market is willing to accept them. It is necessary to fulfill this requirement when an innovation is made out of an invention. This means that innovators are aware of the standards for the success of the innovation. Although most standards are not compulsory, the simple fact that they exist gives them a certain level of acceptance in the market. These standards influence the establishment of a dominant design. This situation makes it necessary for companies to trace and study them and decide upon their use. This area is discussed in detail in Chapter 5.

4.7 Standards to reduce costs

In general, a 'standard' is cheaper than 'variety' due to economies of scale. However, the market demands variety. Many organizations provide variety, because differing customer wishes reduce the market potential. However, organizations employ various standardization strategies such as component commonality and modularity in the product innovation process.
These standardization strategies are discussed in details in the unit 'Product Development and Design'.

5 Standards and market acceptance

Understanding standards and their use during the innovation process is an important requirement for success in the early stages of the product life cycle. Standards influence technological development, and are a source of competitive advantage in product markets. Innovators have to recognize the different types of standards which influence the market acceptance and emergence of dominant design.

5.1 Types of standards

The standards useful for market acceptance can be classified as follows:
- Interference standards
- Quality standards
- Compatibility standards
- Customer interface standards

5.1.1 Interference standards

Interference standards set requirements concerning the influence of an entity on other entities. In terms of product innovation, this refers to the standards such as safety, health and environmental standards. Companies often have to use interference standards because of governmental requirements.

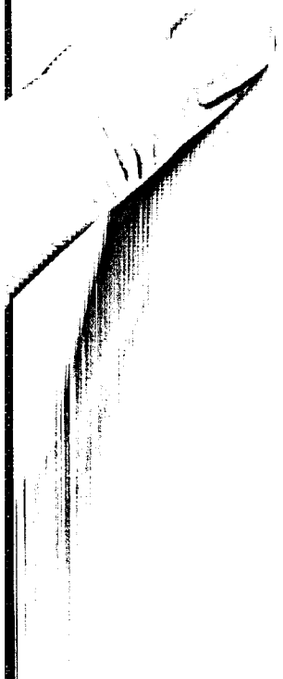
Example 1: Approval of voltage testers (Source: Barendse, 1995)
Steinel GmbH & Co. KG in Herzebrock-Clarholtz produces, among other things, low voltage testers. These are exported to several countries. Many of these use the IEC standard DIN-IEC 1243. The availability of this standard is an advantage compared with the former situation where Steinel needed separate approval

according to different standards (for instance, Germany, Austria and Sweden: VDE 0680 part 5, France: NF-C-18/310, Hungary: MSZ 20862-79, Poland: PN-87 E-08506). In order to meet the different (safety) requirements, the company could choose to have one quality and safety level for all countries. This, then, should be the highest level, which might make the product unnecessarily expensive in other countries. However, diversity in product designs is expensive as well. Moreover, some requirements could not be combined: one example was differences in the prescribed colours of the wires. In such a case, data on standards per country should be available at an early stage of development so that possibilities of meeting them can be considered and the company can decide whether or not the costs of design variants justify exports to certain countries. Steinel has decided to sell all its types of voltage testers on the home market but to limit the types it exports to other countries.

Example 2: CE marking (Source: De Vries, 2005)
CE marking is required for more than 50% of all products. By affixing the mark, the producer declares that he meets the essential requirements laid down in European New Approach Directives. Most of these directives set safety requirements, but requirements on, for instance, health, or environmental issues may be included as well. A Directive is a law at European level that has to be implemented in the national legislation of the member states. The 'new' in the approach is that the requirements are formulated globally and, linked to the directives, European standards are developed in which detailed requirements and/or test methods are laid down. A company that meets the relevant standards is assumed to meet the essential requirements set out in the Directives. Thus, implementing the standards is an efficient way of meeting the legal requirements. The company, however, is allowed to meet these requirements in another way. Though principally voluntary, in practice, these standards are almost obligatory; in more than 98% of these cases where the standards are indeed available, companies use this method to meet the essential requirements. R&D not only has to consider existing requirements and standards but will also try to anticipate future directives and related standards.

5.1.2 Quality standards

Quality standards are set for product properties to assure a certain level of quality. Quality standards are often related to the company's operations, and in many situations, the company is free to set them.



5.1.3 Compatibility standards

Compatibility standards are the standards which refer to the technical specifications that define the fit and interaction between components in a product or between the product and complementary products. A compatibility standard describes the manner in which components in an end product come together or products come together with complementary products.
Compatibility can be further classified into horizontal compatibility and vertical compatibility.

- Horizontal compatibility concerns the fit between functionally equivalent objects. E.g.: Two telephones.
- Vertical compatibility concerns the fit between functionally different things. E.g.: Hardware and software, tracks and trains.

Another classification of compatibility is backwards and forwards compatibility.
- Backwards compatibility means that when a subsequent standard is developed, the new standard should be compatible with its predecessor. In this case there are no conversion costs for the old standard users. E.g.: New software is developed so that old files are compatible with it.
- Forwards compatibility means developing a standard in such a way that future successors will be backwards compatible with it. E.g.: When, in 1982, Philips negotiated with Japanese companies about the specifications of the Compact Disc, they already knew that the CD would also have to be forwards compatible with the CD ROM and CD Interactive, which, at that moment in time, were not yet known to the Japanese (De Vries, 1999, p. 206).

5.1.4 Customer interface standards

Customer interface standards refer to the technical specifications that determine the pattern of interaction utilized between the individual user and an end product for deriving benefits. It provides a consistent interface format that reduces uncertainty, and simplifies usage for the consumer.
One example of this is when an individual interacts with Microsoft's combination of the Windows operating system and application software that is based on certain technical specifications. As consumers become familiar with a particular interface, it becomes costly for them to switch to another product offering the same functional benefits but requiring a different pattern of interaction with the product. Developing the skills necessary to use high-tech products requires technology-specific learning. In effect, when a customer interface standard becomes established, the product and user develop a complementarity, increasing the product's utility. Familiarity makes it costly to

switch to another product offering the same functional benefits but requiring a different pattern of interaction (Sahya & Riley, 2003).

5.2 Factors influencing standards-setting in innovations

There are many factors which influence standards. Interference standards are mainly set by the government and other regulatory bodies. Quality standards are usually set by the company by considering the customer expectations and competitors' products. However, the influential factors on compatibility standards and customer interface standards are not directly visible, so it is worthwhile to discuss them in detail. Some of these are discussed below.

5.2.1 Mode of access to complementary assets

Access to technologically complementary assets is a key driver in the innovation process. Access to complementary assets influences the development of standards in an industry, and is one reason that imitators sometimes outperform innovators.

Factors influencing standards setting in innovation

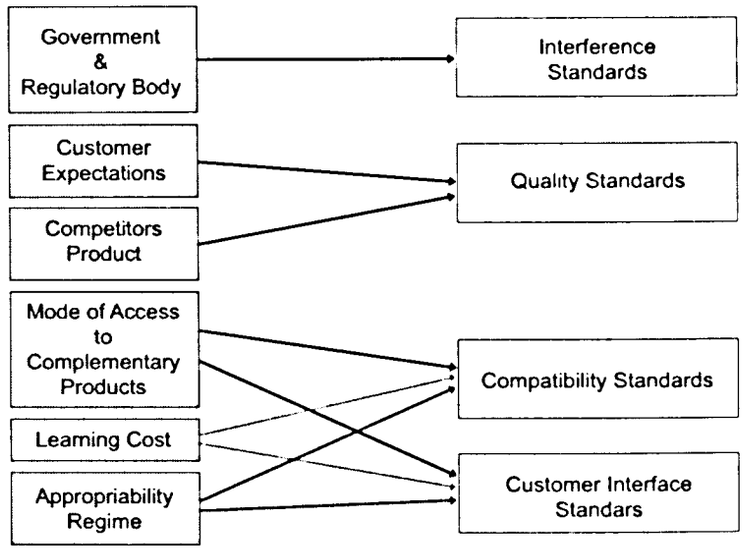


Figure: Factors influencing standards-setting in innovation (© Chandana Perera)

Complementary assets are those particular technical (complementary technologies) and non technical resources or capabilities (marketing, distribution, or service) that contribute toward the composition of a whole product and influence technology selection. Firms access complementary assets either through vertical integration or through contractual arrangements.
When a firm is vertically integrated, there is a lesser need for negotiation with other firms in order to ensure that its product components fit with components made by other vendors, because the former makes all the components and the interfaces itself. The integrated firm may have an incentive to manipulate component interfaces as a means of temporarily reducing competition.
When a firm obtains complementary assets through contractual means, it shares knowledge at the component interface. Then the company gives priority for compatibility standards to ensure the proper fit with components made by other vendors.
In contrast, a firm that accesses complementary assets through vertical integration has a greater potential to tailor the end product to meet customer needs. It will have greater access to information and does not need to expend resources in negotiating, monitoring and enforcing exchange with other firms. Thus, vertical integration provides greater influence over the end product's design, which increases the likelihood of pursuing a customer interface standard (Sahya & Riley, 2003).

5.2.2 Learning costs

Increased demands are placed on potential users to develop skills related to the use of new technologies. 'Learning costs' refer to the loss of productivity when a user changes to a new product or technology.
By establishing a customer interface standard, a firm encourages the consumers to adopt a distinct pattern of interaction with the product. At the same time, vendors and complementary product providers reduce their learning costs by simplifying the interface between the product and other complimentary products or between components (Sahya & Riley, 2003).

5.2.3 Appropriability regime

Appropriability refers to the technological (and legal environment) features that make it easier for the owner of the technology to benefit from the technology. When appropriability regimes are weak, firms may pursue compatibility standards, and when they are strong, they have a stronger propensity to pursue customer interface standards.
Consider the case of the Intel microprocessor architecture that interfaces with a PCI bus within a PC through a compatibility standard. Strategic reasons arising from their whole product development imperative dictates that Intel should

share the interfaces with other complimentary product providers. Sharing interface technology creates a weak appropriability regime. This is an incentive for Intel to pursue compatibility standards, which it does by organizing developer forums. On the other hand, strong appropriability regimes in wireless technology means that firms are actively pursuing customer interface standards, which will enable them to obtain more customers (Sahya & Riley, 2003).

5.3 Standards and customer utility during product innovation

The utility experienced by the customer depends upon the type of standards embodied in new product. This section discusses two principal sources of customer benefits:
1. Network benefits
2. Direct product benefits (Technological advantage)

5.3.1 Standards and network benefits

Network benefits represent the utility a given user derives from a product that is dependent on the number of other users in the same 'network'.
E.g.: A fax machine becomes more useful as the number of fax owners increases.
As the network grows, the opportunities to use the product increase and the variety of complementary products and services offered increases, vis-à-vis competitors with smaller networks. The larger installed base facilities make it easier to exchange information with other users familiar with the product. These effects serve to make the product's performance more valuable to the consumer compared to competitive offerings with smaller networks of complementary providers and users (Sahya & Riley, 2003).
By focusing on the interrelationships in a given product market, a firm can enhance the network benefits perceived by the customer in two ways.
First, compatibility standards encourage the development of a uniform technological platform for which the supplier can create a wider variety of complementary products. Complementary products which conform to an interface that vendors and complementary product producers are familiar with will be more useful than incompatible products or components. This further promotes the development of complementary products, increasing the size of the network of people using that product, more persons can connect to the network, exchange data, and obtain increased benefits simply by virtue of a larger number of people using that product. The compatibility of a mobile phone having a video messaging (MMS) facility with an Ethernet card increases the value of the phone, as more users are able to send an MMS from a mobile

phone to the user. Thus, pursuit of compatibility standards enhances direct network benefits (Sahya & Riley, 2003).
Secondly, a firm can increase the network benefits associated with the product through a customer interface standard. When a customer interface standard starts to become popular, the network of users skilled in using that product increases. Once they have developed a skill, users avoid acquiring alternative skills, due to learning and switching costs.
The more overall functionality and the more functional profit individual users have from their investments, the more willingness there will be to bandwagon the system. This is typical for network effects. In addition to such direct network effects, indirect network effects can also apply. For example, the value of a barcode system increases with the availability of scanning equipment. The higher the number of barcode users, the more scanners will be available and the lower their price. Thus, without improving system functionality for the individual users, the system gains in value from a growth in the number of users: indirect network effects. In the case of a competing system, network effects apply within each system. Due to the characteristics of network effects, one common solution would be better, since the total functionality of one system is greater than the sum of the functionalities of two separate systems. Typically, in these systems the parts have to fit in a certain way, so these are systems for which standards in general, and compatibility standards in particular, are essential. Inventions without standards have no chance of becoming innovations (Sahya & Riley, 2003).

5.3.2 Standards and technological advantage

In contrast to network effects, direct product benefits arise from the inherent technological capabilities of the product. These technological capabilities represent an advantage for the firm if they can be translated into perceived performance superiority for consumers.
Compatible products provide enhanced or new benefits through interaction among themselves, thus delivering increased technological advantage. When product performance depends on the interaction with other products (such as between computer hardware and software components), a compatibility standard, which embraces a broad range of peripherals, increases the technological edge of the product.
At the end-user level, user benefits from high-tech products reach the consumer through the customer interface. One line of thought suggests that because users derive benefits through a customer interface, any technological gains at the component level or improvements resulting from component interactions have to be delivered within the constraints of the customer interface standard (Sahya & Riley, 2003).

5.4 Standards battle for market access

Throughout the product life cycle the company should remain aware of standards that may influence market share. New standards may impose requirements that make it more difficult for the company itself or its competitors to enter the market. The worst situation is that the company's product will no longer meet the new standard and hence not be marketable.

Example: European manufacturers of hoses for gas appliances keep out American competitor (Source: Delaney, 2001)
Dormont Manufacturing Company, US based, manufactures hoses that connect gas appliances to gas outlets. In 1989, the authorities in France and the UK no longer allowed these onto their markets for safety reasons. Dormont decided to have its hose tested to a British standard that contained both design and performance elements. The British Standards Institution, assuming the European directive on gas appliances covered the hoses, issued a certificate for compliance with UK safety regulations, which allowed the company to affix the CE mark to its hose. Dormont's German competitor complained to the European Commission, claiming that hoses were not appliances, but components. The Commission agreed, BSI had made a mistake, the CE mark was ordered to be withdrawn. So, there were no safety requirements for Dormont. However, national standards that contained design criteria still hindered Dormont from exporting to France and the UK. The company succeeded in convincing the British technical committee to revise the British standard to reflect performance criteria. Meanwhile, however, European manufacturers decided to develop a European (CEN) standard. The working paper concerned a design-based standard; the design would exclude Dormont's design. Because of the 'stand-still agreement,' BSI was not allowed to further develop its national standard. The case was brought to the Technical Barriers to Trade Committee of the World Trade Organization. However, the time necessary to correct the situation made further efforts irrelevant for the American company.

5.5 Participation in external standardization

Participation in external standardization may favour the market conditions for the company's products and services.

Example: Participation to delay the process: Philips TVs (Source: DeVries, 2005)
Occasionally TVs catch fire. Statistics show this usually occurs in the last weeks of December, so an external reason is plausible. Internal combustion due to, for instance, a short circuit, occurs accidentally. To avoid fire outside the TV set, the plastic back cover of the TV serves as a heat screen.

Within the IEC it was proposed that stricter requirements for these back covers should be developed. Consumer organizations and the plastics industries were in favour of this: consumers because of the safety issue, and the plastics industry because of a higher turnover in selling more sophisticated plastics. Philips, one of the main producers of TVs, was against the proposal because it thought it could not raise the price of the TVs to allow for the higher costs - consumers would not accept this. They argued that the existing solutions were sufficient since the power consumption had been diminished to less than 200 watts. Therefore, the heat generation was negligible. Since interests may count more than arguments in standardization, Philips expected to lose the game. They therefore developed a strategy to delay the process. They did this by questioning data such as measurement results to underpin the requirements in the standard, and offered their own testing facilities for carrying out additional tests. The strategy was successful: the result was a delay of more than four years. Meanwhile new discussions about the TV covers are taking place, since environmental issues count - the plastics used to prevent or retard fires contain substances that are harmful to the environment. This additional interest has caused a shift in the balance. Now the plastics industry may want to delay the process.

Example 2: Participation for learning: IEEE committee on LANs (Source: Schmidt & Werle, 1998)
Many of the participants in the IEEE standardization committee on Local Area Networks conceded they were there to learn from the other participants rather than support any particular position. This means that even when there is a desire to reach a standard, the process can be lengthy as the participants struggle to understand each other's knowledge.

6 Environmental standards and innovations

The need for regulations to protect the environment is attracting more attention because everyone wants a liveable planet. These environmental regulations are administered through properly written environmental standards.

Environmental standards towards competitiveness

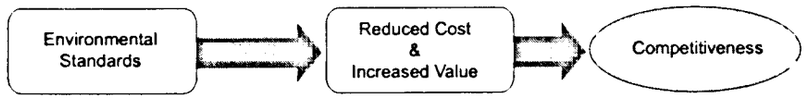


Figure: Environmental standards towards competitiveness (© Chandana Perera)

Even though the environmental standards protect the environment, there is general belief that environmental standards erode competitiveness. The prevailing view is that there is an inherent and fixed trade-off: ecology versus economy.
On one side of the trade-off are social benefits that arises from strict environmental standards. On the other are industry's private costs of prevention and cleanup - costs that lead to higher prices and reduced competitiveness.
If technology, products, processes, and customer needs were all fixed, it would be inevitable for standards to raise costs. However, companies operate in the real dynamic world, not in the static world. Therefore they are finding innovative solutions to pressures of all sorts from competitors, customers, and regulators.
Properly designed environmental standards can generate innovations that lower the total cost or improve its value, and such innovations allow companies to use a range of inputs more productively. This enhanced resource productivity makes companies more competitive.

6.1 Innovation and resource productivity

The studies show that the costs of meeting environmental standards and regulations can be minimized, if not eliminated, through innovations that deliver other competitive benefits. Innovation in response to environmental standards can fall into two broad categories.

1. New technologies and approaches that minimize the cost of dealing with pollution once it occurs. The key to these approaches often lies in taking the resources embodied in the pollution and converting them into something valuable. Companies should know how to process toxic materials and emissions into usable forms, recycle scrap, and improve secondary treatment.
   Example: (Source: Porter & Linde, 1995a)
   At the Rhône-Poulenc plant in Chalampe, France, nylon by-products used to be incinerated. Rhône-Poulenc invested 76 million francs and installed new equipment to recover and sell these diacids as additives for dyes and tanning and as coagulation agents. The new recovery process has generated annual revenues of about 20.1 million francs. New de-inking technologies developed by Massachusetts-based Thermo Electron Corporation, among others, are allowing more extensive use of recycled paper. Molten Metal Technology of Waltham, Massachusetts, has developed a cost-saving catalytic extraction method to process many types of hazardous waste.

2. The second and far more interesting and important type of innovation addresses the root causes of pollution by improving resource productivity in the first place. Innovation offsets can take many forms, including more efficient utilization of particular inputs, better product yields, and better products.

Example: (Source: Porter & Linde, 1995a)
3M improved resource productivity through innovation. Forced to comply with new environmental standards to reduce solvent emissions by 90%, 3M found a way to avoid the use of solvents altogether by coating products with safer, water-based solutions. The company gained an early-mover advantage in product innovation over competitors, many of whom switched significantly later. The company also shortened its time to market because its water-based product did not have to go through the approval process for solvent-based coatings. 3M found that innovations can improve process consistency, reduce downtime, and lower costs substantially. The company used to produce adhesives in batches that were then transferred to storage tanks. One bad batch could spoil the entire contents of a tank. Lost product, downtime, and expensive hazardous-waste disposal were the result. 3M developed a new technique to run rapid quality tests on new batches. It reduced hazardous wastes by 110 tons per year at almost no cost, yielding an annual saving of more than $200,000.
Process innovations to comply with environmental standards can even improve product consistency and quality. In 1990, the Montreal Protocol and the US Clean Air Act required electronics companies to eliminate ozone-depleting chlorofluorocarbons (CFCs). CFCs were used as cleaning agents to remove residues that occur in the manufacture of printed circuit boards. Initially, scientists thought that complete elimination of CFCs would be impossible. Later research demonstrated that alternative cleaning agents could be reused in a closed-loop system. The new method improved average product quality which the old CFC-based cleaning agent had occasionally compromised - while also lowering operating costs.
Responding to the same standards, other researchers identified applications that did not require any cleaning at all and developed so-called no-clean soldering technologies, which lowered operating costs without compromising quality. That innovation would not have happened without environmental standards (Porter & Linde, 1995a).
Innovations responding to environmental standards can also lower product costs and enhance resource productivity by reducing unnecessary packaging or simplifying designs. A 1991 law in Japan set standards to make products easier to recycle. Regulation that requires recyclable products can lower the user's disposal costs and lead to designs that allow a company to recover valuable materials more easily. These environmental standards lead to innovations that benefit either the customer or the manufacturer (Porter & Linde, 1995a).

6.2 Cost of static mind-set on environmental standards

The current undesirable climate is driving up the costs of meeting environmental standards and restricting the benefits of innovation, making the trade-off far higher than it needs to be. The power struggle involved in establishing and imposing environmental standards is consuming enormous amounts of resources. One problem with the adversarial process is that it locks companies into static thinking and systematically pushes industry estimates of the costs of a standard upward. A classic example occurred during the debate in the United States on the 1970 Clean Air Act. Lee Iacocca, then executive vice president of the Ford Motor Company, predicted that compliance with the new standards would require huge price increases for automobiles, force US production to a halt by 1975, and severely damage the US economy. Static thinking causes companies to fight against environmental standards even though complying with these standards could enhance their competitiveness.

Environmental standards - static mind-set vs. innovation

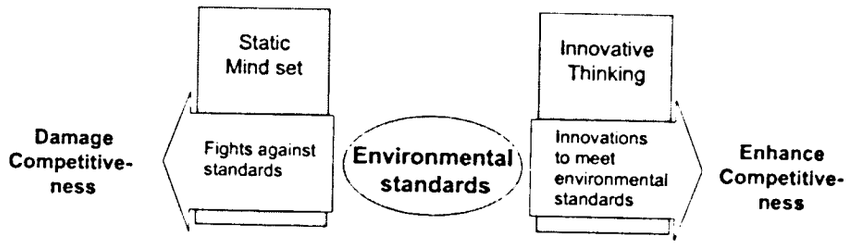


Figure: Environmental standards - static mind-set vs. innovation (© Chandana Perera)

For example, most distillers of coal tar in the United States opposed 1991 regulations requiring substantial reductions in benzene emissions to meet standards. At the time, the only solution was to cover the tar storage tanks with expensive gas blankets. But the regulation stimulated Aristech Chemical Corporation of Pittsburgh, Pennsylvania, to develop a method to remove benzene from tar in the first processing step, thereby eliminating the need for gas blankets. Instead of suffering a cost increase, Aristech saved itself $3.3 million (Porter & Linde, 1995a).

6.3 Innovation-friendly environmental standards

Bad environmental standards deter innovative solutions or render them impossible. Standards can and should promote resource productivity. If environmental standards neglect this potential, by concentrating on cleaning up instead of prevention, mandating specific technologies, setting compliance deadlines that are unrealistically short and subjecting companies to unnecessarily high levels of uncertainty, the system discourages risk-taking and experimentation. Reasons for this include liability exposure and the government's inflexibility in enforcement.
Just as bad standards can damage competitiveness, good standards can enhance it. Consider the difference between US and Swedish pulp-and-paper sectors. Whereas the United States mandated strict emission standards and established very tight compliance deadlines, Sweden started out with looser standards but clearly communicated that tougher ones would follow. Companies in two countries reacted differently. US companies installed secondary treatment systems and stopped there. Swedish producers, anticipating stricter standards, continually incorporated innovative environmental technologies into production process (Porter & Linde, 1995a).

Environmental standards: good vs. bad

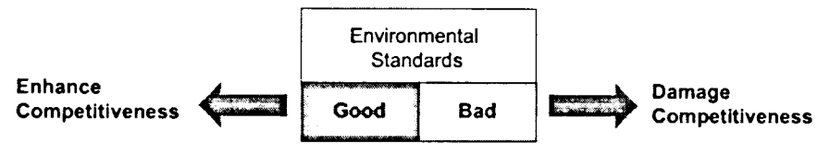


Figure: Environmental standards: good vs. bad (© Chandana Perera)

Authorities have to design environmental standards so that they will promote innovation, resource productivity, and competitiveness, while protecting the environment. The following are some of the important principles to be observed in designing environmental standards.
Focus on outcomes, not technologies: the terms 'best available technology' (BAT) and 'best available control technology' (BACT) should not be used in defining standards or regulations. These terms imply that one technology is best, discouraging innovation.
Standards should not be lenient so that companies can manage with end-pipe or secondary treatment solutions.

Set standards as close to the end user as practical, while encouraging upstream solutions: this will allow more flexibility for innovation in all the production and distribution stages of the end product.
Employ phase-in periods: well-defined phase-in periods tied to industry-capital-investment cycles will allow companies to develop innovative technologies rather than force them to implement partial solutions simply patching over problems (Porter & Linde, 1995b).
Apart from the above principles, authorities should be careful not to damage the competitiveness of their own companies by setting standards which are not ready in other countries. A predetermined set of information requests and interactions with industry representatives should be a mandatory part of the standard development and regulatory process. Authorities must understand an industry's economics and what drives its competitiveness. Market incentives such as pollution charges and deposit-refund schemes draw attention to resource inefficiencies and tradable permits provide continuing incentives for innovation and encourage creative use of technologies that exceed current standards (Porter & Linde, 1995b).

7 Intellectual property rights and standards

7.1 What is intellectual property?

Intellectual property (IP) refers to the creativity and invention of a person. Intellectual property right, often referred to as IPR, allows people and organizations to protect their creativity and inventions in the same way that they own physical property. The owner of IP can control the use of it and be rewarded for its use. Intellectual property is usually a result of creative skill, labour and investment. Without protection, IP would be easy to exploit without paying the creator. Intellectual property rights allow creators to get return for their effort and investment. IPRs provide a vehicle for exploiting IP assets in variety of ways: outright sales, licensing agreements, as a bargaining tool. Ignoring the inherent intellectual property of a business opens up the possibility of competitors taking advantage of its technical innovations, business ideas, goodwill and reputation in the market (Clarke, 2004).

7.2 What are the different types of IPRs?

There are four main types of IPR and they are as follows (Clarke, 2004).
- Patent - for inventions, new and improved products and processes that are suitable for industrial application.

- Trademarks - for brand identity of goods and services, allowing distinctions to be made between different traders.
- Designs - for appearance of the whole or a part of a product, resulting from the features of, in particular, the lines, contours, colours, shape, texture or materials or the product itself or its ornamentation.
- Copyright - for material, for example literary and artistic material, music, films, sound recording and broadcasts, software, multimedia.

7.3 IPR: practical use and development

IPRs can be developed to protect an invention and can be used to raise capital through licensing. IPRs can also be used as a source of information, for instance to check the current state of the technology or a competitor's activity.
While patents are important to many manufacturers, other types of IPR are relevant to other sectors. Service-related businesses rely less on patentable technology and more on brand protection and copyright. If product details can be discovered from the product you market, it is important to protect the IP through a patent. However the process innovation can be kept as secrets without patenting since it is not possible to discover the process details from the product sold.
It is important to realize that more than one type of IPR may apply to the same creation. For example, a patent can protect a product's function, while a registered design can protect its appearance and a registered trademark can differentiate it from similar products (Clarke, 2004).

7.4 Use of IPRs and standards innovation process

7.4.1 IPRs and standards as a source of information

Standards and patents both explain a primarily technical solution. A standard is intended to be used by any party for which it is intended, but a patent is only used by the patent holder. What standards and patents have in common is the fact that they make information available to prevent reinvention of the wheel. In addition to the technical information, patents and standards can provide other forms of valuable information. Depending on the use, information provided by patents and standards can be divided into three main categories: technical, commercial and legal.
Technical information in patents and/or standards provide a solution to a technical problem and avoid duplication of work. This technical information can be further used to identify and evaluate technology for transfer.

A search in patents or standards provides the information such as active companies in any particular area of technology, owners of patented technology, technological trends and competitors. This commercial information on patents and standards is helpful to locate potential business partners and suppliers, and to identify new business and investment opportunities.
Patent and/or standards also provide a wide range of valuable information such as countries where an invention is protected and scope of protection, and how to avoid infringement.
Above information given by patents and standards is very useful for the future innovation and acts as a source of knowledge (Clarke, 2004).

Approaches of inventors - standard or patent

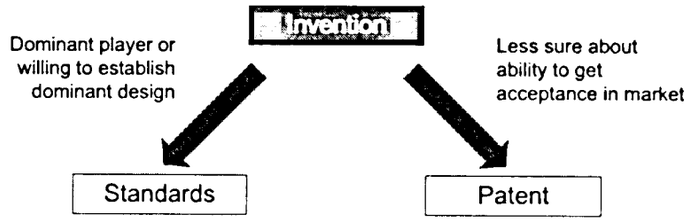


Figure: Approaches of inventors - standard or patent (© Chandana Perera)

7.4.2 IPRs and standards for market success

A company which invents something can choose between patents and standards or a combination of the two, depending on which option is the best for achieving market success. If the company is a dominant player or willing to establish a dominant design, it can attempt to do everything alone and get market acceptance for the product and its specifications. Once the majority of customers buys this product, the product itself or its specifications may become a 'de facto standard' in the market. Microsoft's Windows and related software are the best examples of this (De Vries, 2005).
When a company does not have the capability to secure market acceptance for its innovation, it can earn money by offering licences to others. In other cases it may be wise to give general access to the design by laying it down in a standard. Under certain conditions, standards bodies allow licences to be included in standards. The patent holder should provide a signed statement that he is willing to negotiate licences and rights under patent with applicants throughout the world on reasonable terms. Market circumstances determine what is

'reasonable'. The ultimate case is to offer the whole design for free for inclusion in a standard in order to gain enough acceptance. In such a case, the business advantages should come from first mover-advantages, better production facilities, etc. (De Vries, 2005).

Use of standards in innovation

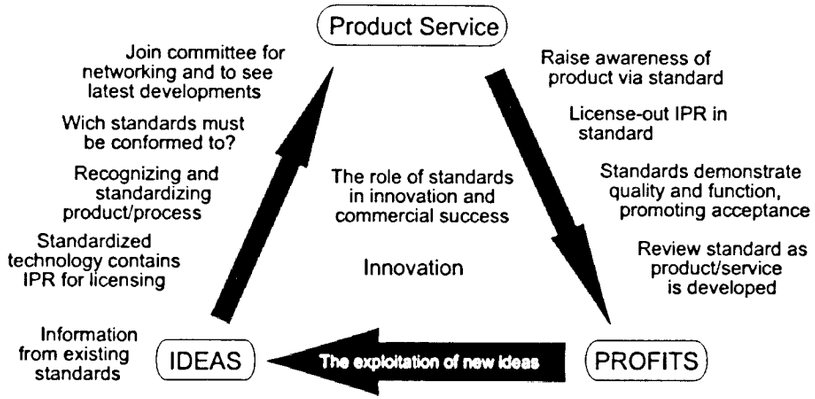


Figure: Use of standards in innovation (Source: Clarke, 2004 with modification)

Example 1: Compact cassettes (Source: De Vries, 2005)
Compact cassettes are used in Walkmans among other items. Philips has patents on them. Nevertheless, Philips has offered licenses for free to other companies. The only requirement is that they have to meet the Philips company standard. This choice was made in order to gain enough acceptance for the product: the choice between a risk of total failure and sharing results with competitors. In the first years after their introduction, good results were possible due to an advantage in knowledge.

Example 2: GSM (Source: De Vries, 2005).
Intellectual property rights are very important in the telecommunications sector. If the technology is to function, (compatibility) standards are essential as well, no matter whether these are de facto standards or formal standards. In many telecommunication cases, de facto standards dominate the scene. Often the standards come from a consortium that possesses the essential patents and that may be extended to a certain extent with parties without patents. In the case of GSM, the specifications of the technology have been laid down in formal (ETSI) standards. In mobile telecommunications standards, the

'game' differs according to each phase: the 'pre-standardization phase', the 'standards production phase' and the 'standards diffusion phase.' GSM faced serious IPR problems. For instance, Motorola has succeeded in collecting substantial licence fees and in influencing the supply market structure. Other manufacturers also tried to influence standardization in such a way that their patents became essential for inclusion in the standard. At the same time, other actors have tried to turn down proposals because of the inclusion of such IPRs. Finally, the common willingness to arrive at an agreed-upon standard has overcome the IPR problems. Motorola has established cross-licence agreements with Ericsson, Nokia, Siemens, and Alcatel.

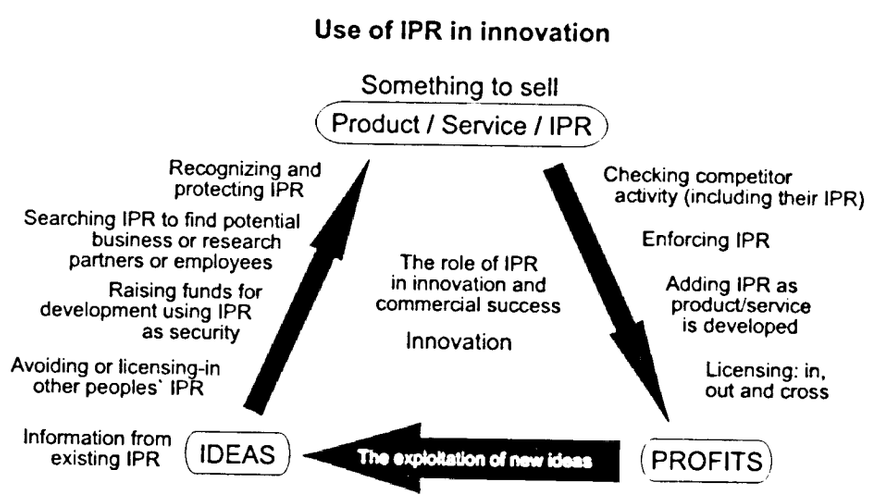


Figure: Use of IPR in innovation (Source: Clarke, 2004 with modification)

7.5 Innovation lifecycle stages - standards and IPR strategies

Standards and IPRs of a business represent an investment from which business expect a return. Therefore, transforming an invention into a marketable product or process, so that it begins to generate revenue, is a crucial stage in the innovation process. A systematic approach for the commercialization of innovation ensures the good returns on investment in standards and IPRs. The following guidance is likely to be most effective when used across the innovation lifecycle of a particular product.

Idea generation
Standards, such as those used in regulations and existing product standards, and published IPR, such as patent specifications, can be used to learn about products and requirements. This can help to focus product development.

Technology development
Once the product requirements have been identified, the technology should be developed. Standards and published IPR, such as patent specifications, can be used to learn about relevant technologies (Clarke, 2004).

Product development
This stage includes feasibility studies, technology acquisition and development, development of product ranges, prototypes and testing, and production.
Standards development and IPR strategies should be considered in this early pre-competitive stage of the innovation lifecycle. There are advantages in collaborating before products and technologies have been firmly set. In this stage, common guidelines can be developed for future standards in order to provide the confidence within the supply chain for investment in new technologies. Early focus on standardization avoids costly investment in the wrong standards. The IPR strategy should consider in this stage, as a minimum, the ability of the developed business or service to operate freely of competitive IPR and, as a maximum, should cover the acquisition, cross-licensing or licensing-in of IPRs to establish control of the intellectual property landscape around the business. The cost and benefits of standards and IPR must also be considered in budgets and resources (Clarke, 2004).

Introduction to market
In this stage, the product or service is launched into the market. A strong brand identity can be established using trade marks in a name, logo or slogan, and design originality can be protected by registration. Design rights might also exploited to protect three-dimensional product appearance. Diffusion of the product can be aided by publishing IPRs and by entering the standardization process. Resistance towards accepting new products can be overcome by quality, functional and compatibility standards (Clarke, 2004).

Market growth
In this stage there may be a period of rapid market acceptance and sales growth. New market segments are searched to introduce modified or differentiated products. Standards development and strategic alliances can be used to develop compatible products and to lower development cost. Standards may also be used to obtain royalties from IPR. Competitor's public IPRs may also be used to gauge the market and to provide development ideas (Clarke, 2004).

Market maturity
In this stage there is a slow down in sales growth because the product or technology has achieved acceptance by most potential buyers. Incremental developments take place to meet changing customer needs. The development of new standards can focus this incremental development and reduce the number of solutions, resulting in economies of scale. Customer loyalty to the brand must be maintained. Licensing-out of IPRs may be used to solve patent disputes and licensing-in may be used to develop the firm's own products (Clarke, 2004).

Market decline
In this stage sales fall and profits drops due to substitute technology offering enhanced performance, changed consumer taste and legislation.
Suitable strategies in this stage include cost reduction through standardization, IPR protection of development and accessories, highlighting product performance using standards and protecting aesthetic product improvements using registered design (Clarke, 2004).

8 Concluding remarks

Standards must not create barriers to innovation. Standards must be as minimal and flexible as possible, providing the limited framework in which technology can be developed and transformed into useful products and services as rapidly as possible. Standards must recognize the rights of those who own intellectual property.
Because of standardization, railroad tracks are the same gauge, people are able to travel the continent of Europe on a Eurorail pass, without changing trains at every national border. The trains run on a schedule based on something called standard time. Economic unity depends on a standardized transportation network. But what if a standards body had decided that the engines all had to be built according to very detailed, identical specifications? Then we might still be living in an age of steam locomotives. As regulations become more complex, innovation becomes bogged down, and economic incentive shrinks.
Another definition of the world 'standard' is quality. A standard is a benchmark, a symbol of purity or excellence against which everything else is measured. Standards enable consumers to raise their sights and expect the best. Standards create competition, which in turn leads to higher quality and better service. Competition and innovation are part of a system that gives inventers and authors exclusive use of their creations for a limited period. This appears to create a conflict with the concept of standards. For example, a standard that uses technology covered by issued patents cannot be put into

effect unless the owners of the patents agree to license them on fair and reasonable terms.
Product standards should be written as minimally as possible, leaving the maximum possible room for future innovation by competitors. Standards should concentrate on essential performance. In the telecommunications field, for example, this covers what a product must do to achieve essential interface compatibility. Standards should not be detailed descriptions of how a product or system must be designed. The more detail it contains, the more likely a paper standard written before the first working prototype will be to even prohibit the desired essential function from being achieved. If the standards body has a slow deliberative process, then by the time the necessary changes to the standards are made, any existing world technological leadership might be lost.
Standards can play a key role in establishing a large unified market, and how important they are for more global applications of new technology. At the same time, standards bodies should focus on their main goal - to make it easier to bring the benefits of technology to consumers. Today, there is considerable opportunity for improvement. In telecommunications, there are complex organizations driven by the goals of governments and large service providers, but only some manufacturers. Clearly, these groups can make useful contributions to the development of standards. But they do not serve the consumer when they create a scenario of complex standards, restrictions on the rights of intellectual property holders and a curious attempt to further industrial policy through standards.
The expectations of consumers for the best technology are often of secondary importance to standard-makers driven by a different agenda. Standards bodies should be encouraged to involve user groups and others who can provide a consumer perspective to the standards-setting process.
Standards can provide the framework by which an enterprise can develop technology and do business in any market in the world. Standards must recognize the rights of those who own intellectual property, and must not discourage investment in research and development. Standards must not create barriers. Standards must facilitate the free flow of information, goods and services and ultimately innovation which provides a better quality of life.

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10 Glossary

Compatibility standards
Compatibility standards refer to the technical specifications that define the fit and interaction between components in a product or between the product and complementary products. A compatibility standard describes the manner in which components in an end product come together or products come together with complementary products.

Complementary assets
Complementary assets are those particular technical (complementary technologies) and non-technical resources or capabilities (marketing, distribution, or service) that contribute toward the composition of a whole product and influence technological selection.

Complementary products
Complementary products refer to the products which are used together to enhance the benefit to customer.

Customer interface
The pattern of interaction between the user and product.

Customer interface standards
Customer interface standards refer to the technical specifications that determine the pattern of interaction that is utilized between the individual user and an end product for deriving benefits. It provides a consistent interface format that reduces uncertainty, and simplifies usage for the consumer.

Dominant design
Dominant design in a product class is the design that wins the loyalty of the marketplace, that which competitors and innovators must adhere to if they expect to command a significant market following.

Environmental regulations
Rules made by an authority to protect the environment.

Environmental standards
Set standards used to prevent damage to the environment.

External standardization
External standardization refers to observing the standards set by an external body such as a national standards organization or international standards organization.

IEEE
Institute of Electrical & Electronics Engineers

Innovation
Activity of developing a new element into a commercially useful element, the new element can be a product, process or service

Intellectual property
Intellectual property refers to the creativity and invention of a person. People can own intellectual property in the same way as they own physical property.

Interference standards
Interference standards set requirements concerning the influence of an entity on other entities. In terms of product innovation, this refers to standards such as safety, health and environmental standards.

Invention
Creation of a new idea for a product, process or service.

IPR - Intellectual Property Rights
Intellectual property rights refer to a person's ownership of the creative ideas behind an invention.

Learning cost
'Learning costs' refer to the loss of productivity when a user changes to a new product or technology.

Quality standards
Quality standards are set for product properties to assure a certain level of quality.

R & D
Research & development

Resource productivity
Effective utilization of resources in the production process.

Technological trajectory
Path followed in developing the technology for a particular product.

Vertical integration
Extent to which a firm is actively engaged in a different strategy for the product transformation process.

11 Key questions

- Does standardization always hamper innovation?
- What is dominant design?
- Are there any factors other than technology influencing dominant design?
- Can standards be used in processes other than the product in innovation process?
- What is the difference between standards in dominant design and other standards such as interference, quality, compatibility and customer interface standards?
- What are the factors influencing standard setting in innovations?
- Do environmental standards always increase the cost of products?
- Can innovation-friendly environmental regulation be formulated?
- What are the commonalities and differences in standards and patents?
- What are the basic principles to be followed by standard makers in order to enhance innovations?

Tineke M. Egyedi · Richard Hawkins

Abstract

Most lectures discuss the formal standards bodies. Standards consortia, on which this lecture focuses, are different. They play their own coordinative role in the market. They have, rightly or wrongly, been criticised for being undemocratic and praised for delivering quick results.
Here, we address the ambiguities that surround consortia, their diversity and reasons for their proliferation. We critically review the democratic rhetoric that surrounds consortia by comparing written standards procedures of consortia with real-life experiences in consortia and formal standards bodies.
Consortia have strongly affected the formal standards system - but also vice versa. The lecture closes with a discussion about the future role of consortia in the current standardisation landscape.

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1 Introduction

Although no single definition is universally accepted, the term 'standards consortia' usually refers to alliances of companies and/or organisations that aim to develop publicly available standards or technical specifications for the purpose of coordinating technology and market development in a specific ICT area.
In the late 1980s and early 1990s, the number of industry consortia, sometimes referred to as fora, that were producing ICT standards seemed to be growing exponentially. These organisations took many forms, but all of them operated to a greater or lesser extent outside or alongside the formal international standards system of ISO/IEC JTC1 and the ITU. These consortia were founded by the key ICT industry players such as IBM, Bull, Sun Microsystems, Microsoft and Oracle. Participation in their working committees became widespread and the documents they produced, which often the consortia were careful to call 'specifications' rather than 'standards', became widely used.

As regards the coordinative role of consortium standards, the basic theory of standardisation is that efficiencies can be gained by eliminating or combining markets through the coordination of technologies and practices. This is the main economic implication of 'variety reduction' which is a fundamental benefit of standardisation. Where too many redundant markets proliferate, every actor in the marketplace becomes subject to decreasing returns (Katz & Shapiro 1986; Arthur 1989). By eliminating such variety, the consolidated market should yield more benefit to more stakeholders, thus compensating for the losses from the elimination of smaller markets.

However, not every variety reduction really creates more value. We have to be able to demonstrate that the resulting consolidated market has facilitated the creation of new markets. The classic success story is machine components and screw threads, which, through standardisation, both lowered the costs of these commodities and allowed suppliers of machine goods to sell to a wider variety of customers, thus enlarging the market overall (Thompson, 1954).
The consortia phenomenon proliferated as a new method of coordinating technology and markets, although many issues and questions still arise as to the overall success or efficiency of this method.

Consortia usually focused upon subject areas that were not part of the mainstream of formal standardisation activity. Many of these new subjects emerged from transformations in the ICT industry brought on by the convergence of information, telecommunication and broadcasting technologies, by the migration to Internet platforms and by the development of ever more specialised application and service environments. In other cases, however, a consortium would address the same technical areas as a formal standards body. Sometimes this would result in direct competition, but often it would just create ambiguity

or confusion. Moreover, the 'informal' and sometimes select nature of consortia outputs could create special problems where it might be necessary to reference a standard in a regulation or in a public procurement regime.

The original rationale for the consortium phenomenon was to solve a time-to-market problem. Given the very short life span of a typical new ICT product, the perception was that the formal standardisation system was too slow and bureaucratic to produce standards in a timely fashion. The validity of this rationale has since been disputed, but it is undeniable that the contribution of consortia to the stock of standards is significant. An EU report notes that consortia currently produce 60% of the ICT standards used in the EU (DLA Piper 2007, p.17). For individual companies, the stock of consortia standards used will often be much higher (Dickerson, 2007).

One unavoidable outcome of consortia activity was to throw the institutional environment for ICT standardisation into turmoil. For the first time, the status of the formal standards bodies as the preferred party in standards making was called into question both by market and government actors. The historically close and often exclusive ties between these actors and the formal national, regional and international standards bodies became weaker. Since the 1990s, the formal bodies have responded by making many changes: for example, introducing new procedures and revising existing procedures in order to shorten the standards development cycle.
Nevertheless, many of the tensions remain, and there is still much polarisation of opinion about the function and impact of consortia as part of the global ICT standards system. In order to fully understand why consortia are seen to be a problem by some and a solution by others, we must look not only at institutional competition between standards bodies, but also at competition and cooperation between various public and private stakeholders in standards outcomes.
It is especially important to understand the role of governments in this context, both as promoters and users of standards. In some cases, regulatory responsibilities involve government directly in standardisation strategies. But even where there is no regulatory responsibility, governments are among the largest users of ICT. Accordingly, their procurement power can play a large role in the formation and aggregation of markets for ICT goods and services.

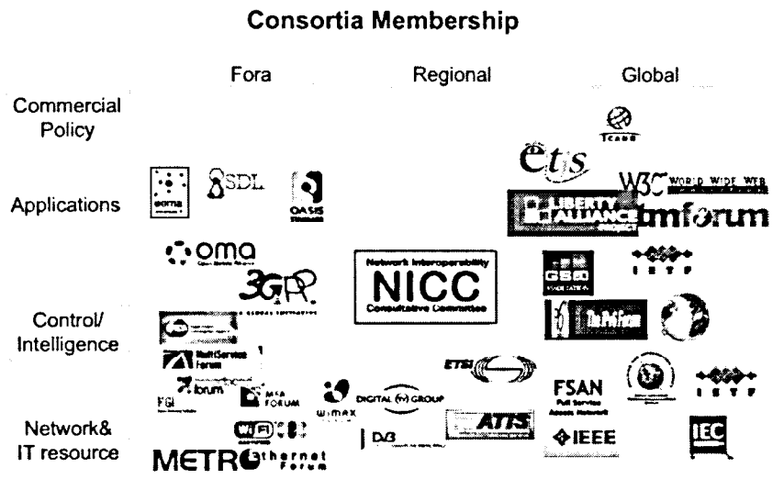


Figure: The importance of standards consortia to a major service provider is indicated by its consortium memberships. The figure lists the main memberships of one such provider. Private communication K. Dickerson, 2-7-2009 (© Tineke M. Egyedi)

2 What is a standards consortium?

There are broadly two ways of defining standards consortia and their activities.

In the narrowest sense, the term 'standards consortium' refers to an alliance of companies and/or organisations that aims to develop publicly available standards or technical specifications for the purpose of coordinating technology and market development in a specific ICT area.

Many consortia focus on developing a specific standard (e.g. ATM Forum) or standards for a specific application area (e.g. W3C for the web environment). These consortia are financed by membership fees. In practice, most large ICT companies are members of many consortia, although they may play extensive roles in only a few of them. Even within this narrow definition, however, the term can cover a wide variety of alliances.

Standards Consortia List

There are more than 230 consortia today. Examples are:

- ASTM International
- Bluetooth - Bluetooth Consortium
- DVD Forum
- Ecma International
- GS1 - (Formerly EAN)
- HL7 - Health Level Seven
- IEEE - Institute of Electrical and Electronic Engineers
  IETF - Internet Engineering Task Force
- MPEG Industry Forum
- OASIS - Organisation for the Advancement of
  Structured Information Standards
- OMA - Open Mobile Alliance
- RosettaNet
- SEMI - Semiconductor Equipment and Materials International
- TETRA MoU Association - Terrestrial Trunked Radio
- UMTS Forum - Universal Mobile Telecommunications System Forum
- Unicode Consortium
- VITA - VMEBus international Trade Association
- W3C - World Wide Web Consortium
- Wi-Fi Alliance
  WiMAX Forum - Worldwide Microwave Interoperability Forum
- XBRL - Extensible Business Reporting Language
- Zigbee - The ZigBee Alliance

Figure: Standards Consortia List (Source: CEN/ISSS Standards Consortia list, CEN/ISSS, 2009)

Specification consortia focus solely on the development of technical standards or specifications (Updegrove, 1995). These may take the form of R&D-oriented and pre-competitive research consortia (Updegrove, 1995) or proof of technology consortia (Weiss & Cargill, 1992). But there are also implementation and application consortia that focus on heightening the usability of existing standards (Weiss & Cargill, 1992), or to formalise dominant existing practices and de facto standards. Still others are strategic consortia, whose foremost goal is to promote the adoption of a particular technology (Updegrove, 1995), to organize educational activities for users of standards (Hawkins, 1999), or in some cases to combine these activities with specification development.

In a wider sense, however, the term 'standards consortium' is used simply to distinguish an informal standardisation initiative - which nevertheless can be highly organized and well funded - from the formal standards system revolving around ISO, IEC, ITU, and their regional and national counterparts. In other words, the term standards consortium refers broadly to all non-formal standards organisations that develop publicly available standards or technical specifications for the purpose of coordinating technology and market development activities.
This broader definition also includes organisations and alliances in which experts participate as individuals: that is with or without official membership in the consortium, and with or without a formal relationship to an institutional member of the consortium. The Internet Engineering Task Force (IETF) is a good example of this kind of consortium. In the 1990s, it played an important role in defining a new participatory model for standardisation, based upon open submissions by individual experts. In a similar fashion most of the inputs to IEEE standards committees are likewise provided by individuals (expert members of this professional organisation). In all of these cases, however, it may in practice be difficult to determine how much of the input into this type of consortium is individual expertise or otherwise inspired by the strategies of companies or organisations that employ these experts.

In this wider definition, where standards consortia are contrasted with the formal standards bodies, the formal standards system is implicitly presumed to be clearly circumscribed. However, there can be a lot of ambiguity within the formal system itself as to what is or is not a formal standards body. There is a significant difference between, for example, the European standards system, which is discussed in Chapter "The European Standardisation Regulatory Framework". of this book, and the US standards system. In the present context, it is especially important to understand some of the idiosyncrasies of the latter.
The US standards system consists of a huge array of independent industry associations - like the Institute of Electrical and Electronic Engineers (IEEE), ASTM International (originally the American Society for Testing and Materials) or the American Petroleum Institute (API). In most cases, these bodies also become standards developers accredited by the American National Standards

Institute (ANSI), i.e. 'ANSI-accredited', and operate according to ANSI rules. This means that some of the standards they develop - but usually only a few of them - are subsequently adopted by ANSI as US National Standards. These can then be injected into the international arena through ISO/IEC. But mainly these organisations set standards for use within their own industries. For example, API standards apply globally in the petroleum industry, irrespective of their status as ANSI standards. The point is that all of these organisations are financially self-supporting and operate independently from ANSI or the US government. Many of their standards are provided to the market directly, without going through ANSI at all.

From the European standpoint, all of these US standards bodies might look like consortia. But this simply illustrates the differences between the two systems. The US national standards system was constructed on the basis that its role was to coordinate a multitude of otherwise independent industry-based organisations. Thus, the US model is already oriented towards something like a consortium model - certainly much more so than the European standards system (Hawkins, 1999, p.164).
This said, the rate of growth in ICT consortia in the late 1990s was a new phenomenon even in the US. One cause of the latter was a change in the US competition regime regarding collaborative R&D arrangements (Hawkins, 1999). US anti-trust law discouraged US firms from developing common technical specifications except through formal standardisation processes. This regime was eased by changes in US laws from 1988 onwards that encouraged closer R&D collaboration between US firms. It is against this background that most of the current generation of consortia began to emerge.

The US system is inappropriate for most individual European countries for the simple reason that their domestic markets are small. For example, it is unlikely that an institution as large and influential as the IEEE could grow out within small country like the Netherlands or Sweden. The possibilities might increase at European level, but although national champion standards are not unknown in Europe, such a decentralised system would probably now be precluded by the CEN/CENELEC/ETSI structure, which encourages standards initiatives to be undertaken and coordinated at the EU level. Thus, it might make more sense for European ICT companies simply to join US-based organisations and consortia rather than to establish rivals. And indeed, although most consortia are US-based, a large part of their membership is drawn from Europe and Asia. That said, probably the oldest consortium in the ICT field is Ecma International, which was established in the early 1960s, long before the boom in consortium formation began.



Figure: The first president of ECMA, Mr C.G. Holland-Martin ICT, 1961-1962 (© ecma-international)

3 Consortia as a solution

The consortium phenomenon can be considered to be both a solution and a problem depending upon the institutional perspectives of various actors and stakeholders. In order to sort out how and why these perspectives can differ, it is important to consider why consortia arose and proliferated in the first place. What needs did they aim to meet? Have they met these needs?

We noted the time-to-market rationale above, but at best this provides only a superficial explanation. Although consortia have been operating for many years, there is as yet no conclusive evidence that the consortium system as a whole delivers usable standards any faster than the SDO system. Doubts have been raised about the faster speed of consortium standardisation (Hawkins, 1999;

Krechmer, 2000; Egyedi, 2006). Indeed, in some cases, the SDO system can be very efficient. MPEG and JPEG are good examples of formal standards that were established relatively quickly within the ISO system.

In many cases, however, comparisons are difficult in that consortia and SDOs may have quite different objectives with regard to their processes and outcomes (Cargill, 2000). In particular, consortia activities are often much more closely allied to the market strategies of stakeholders in particular technology markets. Typically, consortia do not just set technical specifications. They also act to coordinate the relationships between technology suppliers and users.

Thus, it must also be considered that one of the reasons for preferring consortia over formal SDOs may be that the stakeholders have different expectations from consortia. Much consortium activity goes beyond standards setting as such and involves actions aimed directly at coordinating complementary markets around standardised technology platforms. For example, this strategy has been documented in studies of value-added services environments in the mobile communication sector, where the consortium specifications are as much a factor in business models for exploiting technology platforms as they are in the technology as such (Gawer & Cusumano 2002; Ballon 2007; Hawkins & Ballon 2007; Ballon & Hawkins 2009).

The consortium phenomenon and its implications can be explained in terms of all of the above factors provided that we also see it in the context of significant and interactive developments in the strategic orientation of the ICT industries, notably the Internet and its impact on the basic technical paradigms of both public and private networking.

Beginning in the 1980s and gaining a spectacular boost in the mid 1990s with the advent of the World Wide Web, the orbits of the telecommunication and computer industries have become inextricably intertwined. The spectacular diffusion of the Internet that began in the mid-1990s forced both the ICT industries and many of the providers of networked services and content to rethink the commercial implications of truly open networks.

It is highly significant that the interfaces with and within the Internet feature very prominently in the working agendas of most consortia that are engaged either proactively in developing the potential of the Internet in specific market segments (for example, regarding 3G and 4G mobile services), or in responding to the implications of the Internet in terms of transmission requirements, network management capabilities, and so forth. It is also significant in this regard that the membership composition of many consortia includes probably a greater array of consumer electronics, software and digital content providers than was common in the days when most SDO committees were dominated by vendors of data transmission and processing equipment and by public and

private network operators. This may indicate a degree of rebalancing of institutional interests and power in the standards setting process.

Moreover, the Internet standards regime has never operated within the ISO/IEC or ITU systems. It has largely developed according to its own principles and rules. For a growing number of stakeholders - especially those with no historical investment in the data processing and transmission businesses, as normally associated with standards work programmes in the established SDOs - we might surmise that pursuing standards within this framework would present clear risks. The SDO system, on the other hand, retained many technology and institutional legacies that might impede rapid exploitation of commercial possibilities in new network environments like the Internet.

4 Comparing procedures and practices

As participation in consortia was becoming increasingly mainstream in ICT industries, a debate arose about their strengths and weaknesses in comparison to the existing formal standards bodies. The discussion was formulated in terms of a 'consensus versus speed' dilemma. The general feeling was that standards consortia worked more effectively, but that they had restrictive membership rules and, foremost, were less democratic than the formal standards bodies. There was a highly rhetorical aspect to the debate: protagonists as well as opponents of the consortium process avoided specifying what was meant by 'democracy' (Egyedi, 2006). As noted, several studies have questioned the basic propositions in this debate. Their analyses suggest, firstly, that regarding the procedures and standard development time frames of consortia, the differences to formal standards bodies are less clear. Secondly, the distinctions are even more blurred if the actual standardisation practices are compared rather than the written procedures.
This is illustrated in the following, where we take a closer look at and compare both standards environments.

4.1 Written membership and decision procedures

Standards procedures shape committee processes. They mediate normative ideas and values. Egyedi (1996, p.62, 92) speaks of a standards ideology'. Apart from a slight shift during the past decade (e.g. direct membership of interested parties in ETSI), the standards ideology of the international formal standards bodies has remained remarkably stable. Ideological elements such as the consensus principle; the voluntary application of standards; national membership

via the national standards bodies; the broad constituency of national delegations; democratic working methods by means of a 'well-balanced influence of national members' in the management bodies of standards organisations and an open, democratic process of decision-making; widely used and thus in principle international standards; high quality standards; and a rational, technical discussion are still striven for. At stake is what could be termed a 'democratic' standards ideology, since the democratic working procedures are seen by many to define the workings of the formal standards bodies (Egyedi, 1996).

Stages of the development of international standards

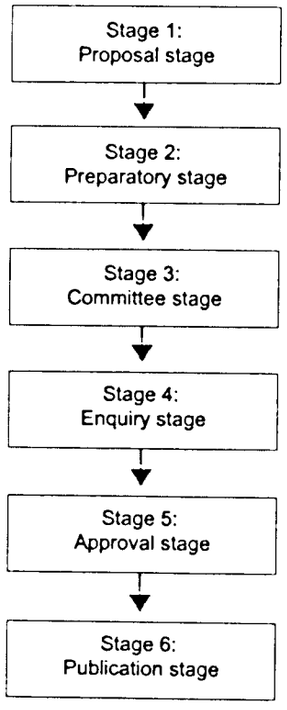


Figure: ISO principles of standards development (© ISO)

In contrast, strong doubts exist about the democratic quality of consortium standardisation processes. The report of the Center for Regulatory Effectiveness (CRE, 2000) explicitly mentions that consortia deliver non-consensus specifications. Consortium participation is more overtly tied to corporate strategies, and consortia processes have fewer checks and balances than the formal SDOs (Cargill & Bohlin, 2007). Doubts exist in particular about the openness of consortium membership (i.e. diversity of participants and inclusion/exclusion of groups), and the way decisions are taken (i.e. consensus and minority treatment). For a full picture, the procedures of the more than 230 consortia should be studied. Here, we use two cases for purposes of illustration. We examine the procedures of Ecma International and the World Wide Web Consortium (W3C), two high-profile and internationally active standards consortia. Ecma is an international Europe-based industry association for standardising information and communication systems founded in 1961. The W3C was founded in 1994.

Membership

In principle, Ecma and W3C membership is open. For example, small and medium-sized enterprises and educational institutions can become members of both consortia. But they have membership fees. Their fee structure roughly takes company profit into account: the more revenues, the higher the fee. More specifically, besides company revenues, W3C fees also vary depending on the type and location of headquarters of an organisation (as an indicator of regional development)[1]. Full W3C members pay US$ 68,500 per year; all other members pay US$ 7,900.

Ecma membership rules distinguish between company members and not-for-profit members. Ordinary members pay 70,000 Swiss francs; associate members pay 35,000 Swiss francs, other categories pay less. Not-for-profit members are exempted from fees.

Decision procedures

In Ecma the ultimate power lies in the hands of the General Assembly, in which only ordinary members have a vote. At this level, decisions about standards are taken by a simple majority[2]. Ecma committee members elect their chair. If there is a deadlock in a technical committee, voting takes place by simple majority of the members present at the meeting.

In W3C, formally, the director and the chairs of W3C standards committees have far-reaching decision-making powers. However, "consensus is a core value of W3C. To promote consensus, the W3C process requires chairs to ensure that groups consider all legitimate views and objections"[3]. In W3C all members have voting rights, not just the full members.

[1] http://www.w3.org/Consortium/fees (consulted June 2009)
[2] http://www.ecma-international.org/memento/Ecmabylaws.htm (consulted June 2009)
[3] http://www.w3.org/2005/10/Process-20051014/ (consulted June 2009)

The emerging picture is very mixed. The membership-funded nature of consortia could in some cases reduce the participation of more marginal groups even further than the formal standard bodies do because of higher membership fees and coordination costs. There is as yet no reliable data to corroborate this trend.
Aside from the membership fees, both consortia show varying degrees of inclusiveness (authority, simple majority, consensus) at different decision levels. W3C combines the more extreme organisational choices, i.e. of Tim Berners-Lee as the ultimate gatekeeper and of a committee process that strongly echoes key elements of the formal standards ideology: consensus, an emphasis on widely used and thus, in principle, international standards (i.e. by including the level of regional development in the fee structure), and a rational, technical discussion ("legitimate views and objections").



Figure: Tim Berners-Lee, founder and director of the World Wide Web Consortium since its inception in 1994 (© W3C)

Where the 'openness' of the standards process is concerned, while formal bodies usually restrict access to committee drafts - and seek consensus within the group of participants in the committees - some consortia actively seek comments from outside and post their drafts on the web (Rada, 2000).

4.2 Unruly practice

Written procedures are not an entirely dependable source for assessing similarities and differences between the two standards environments. Consortia typically have an informal way of handling standards procedures (Hawkins, 1999). As the next section shows, low-quality standards may result.

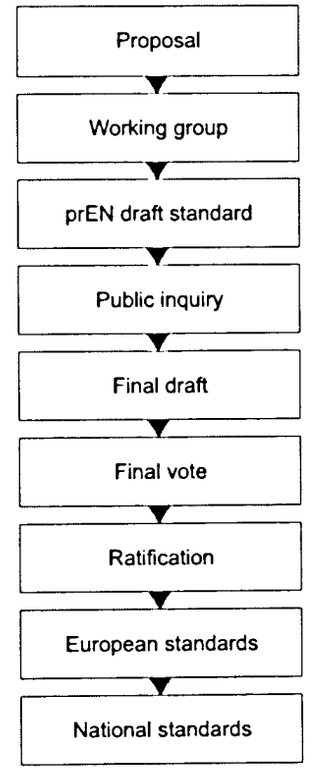


Figure: Developing European standards (© pro-norm)

DIN standardisation process

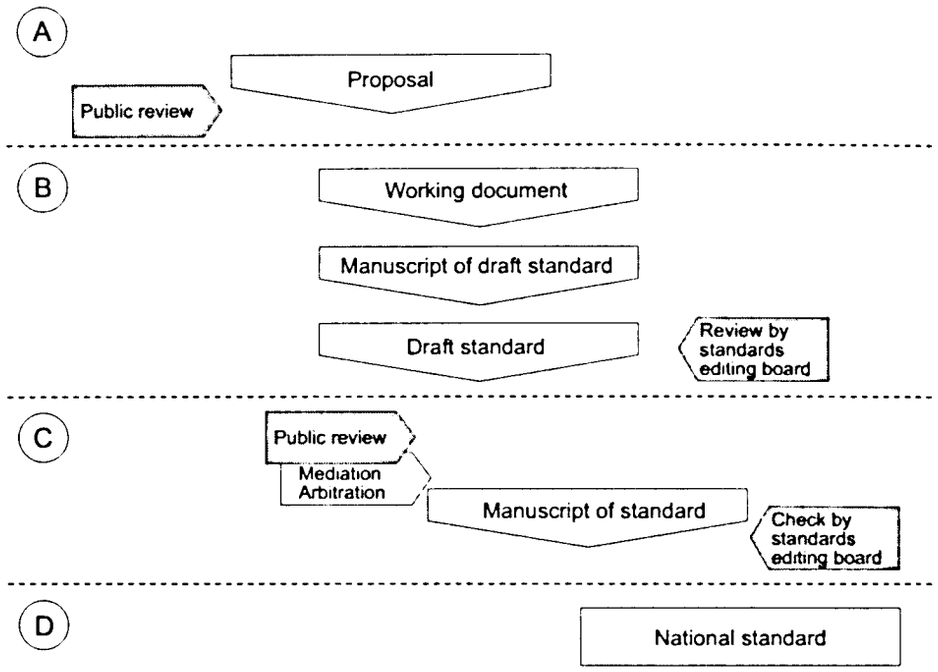


Figure: DIN standardisation process (Source: DIN 2005)

But practice also diverges from theory with regard to the formal standards bodies. Formal standards processes are more closed and exclusive than the standards bodies themselves and governments would like them to be. The participation of end-users and SMEs is very low (Jakobs, 2000). Indeed, for decades now, the lack of representation of key user and consumer interests in formal standardisation bodies has been recognized by the SDOs as a serious problem. The lack of specialised knowledge and the high costs of participating are mainly identified as causes. Whether in consortia or in SDOs, standards-making is never free of strategic interests and its costs are normally sustainable only by larger institutional and corporate entities (Hawkins 1999). In other words, although consortia more explicitly target industrial parties, in practice the standards environments largely include and exclude the same constituency.
Furthermore, formal procedures can be strategically exploited in a way that contradicts all intentions. Examples are the staging of a vote during Christmas holidays (Egyedi, 2001), but also the dominant presence of US multinationals in European national delegations (Cargill, 1999).

4.3 Case: War between ODF and OOXML

The unruly practice is illustrated by the recent ODF - OOXML document standards war. In this war, the key players, the Ecma consortium and the Joint Technical Committee of ISO/IEC (JTC1), play a questionable role in market coordination.

Features	ODF	OOXML
Originally submitted by	Sun Microsystems	Microsoft
Standards consortium	OASIS	Ecma International
XML-based	Yes	Yes
Aim of supplier independence?	Yes	No
ISO/IEC standard	ISO/IEC 26300	ISO/IEC 29500
Year	2006	2008
ISO/IEC JTC1 procedure	PAS procedure	Fast Track

Figure: Comparison between ODF and OOXML (© Tineke M. Egyedi)

In a nutshell, the war is about the ease of exchanging documents made with software from different companies (vendor-independent document exchange) and the digital sustainability of old documents. The latter refers to future access to the vast amount of documents, i.e. text documents, spreadsheets and presentations, created with proprietary Microsoft applications. Future accessibility to these documents depends on Microsoft. The company would need to decide to keep supporting all past software releases, which it currently does not. Consequently, the digital sustainability of old documents is uncertain.
To ease vendor-independent document exchange and improve the digital sustainability of documents, OASIS, a standards consortium, developed the Open Document Format (ODF) standard. This consortium standard was ratified by JTC1 in 2006 (ISO/IEC 26300). Microsoft did not participate in the OASIS standard process. In December 2005, it started a competing standards process in Ecma based on its own OOXML specifications. The resulting Ecma standard, ECMA 372 (ed. 1), was not implementable, not even by Microsoft. Despite its lack of quality and the existence of an overlapping standard (ISO/IEC 29500), JTC1 accepted the Ecma standard for fast tracking. The JTC1 OOXML standardisation

process was highly disputed (Egyedi & Koppenhol, 2009). Among other things, JTC1 introduced new procedures like block voting to handle the more than 1000 comments from the national bodies.

The ODF-OOXML war illustrates that where the stakes in ICT are very high - here: breaking open the market for document processing and exchange - JTC 1's system of national interest representation cannot withstand the power of multinationals. Multinationals can afford to participate in and effectively influence a multitude of national committees (Cargill, 1999; Egyedi & Koppenhol, 2009), which undermines the nationally-based formal system where
"(...) national bodies have the responsibility of ensuring that their technical standpoint is established taking account of all interests concerned at national level (...)" (ISO/IEC, 2009, p.7)
Under such circumstances, the quality of consortium standards is likely to drop, and formal bodies are more likely to apply the fast-track procedure uncritically and slacken their ideals of an 'interest-balanced, technology-oriented and impartial standards process'.

Enforce by dominance or develop by cooperation



Figure: Enforce by dominance or develop by cooperation: "THIS is the standard or die!" "But Apius Gaius! We just developed such a good one ourselves. Come on and join us!" (© Beeldleveranciers.nl)

5 Impact of consortia

The proliferation of consortia shows that consortia are a solution for some but they are viewed as a problem by others. Three problematic issues are discussed below: the institutional competition which has arisen between standards consortia and the formal standard bodies, the relevance of 'democratic' consortium standards to governments, and the difficulties industry has with consortia.

5.1 Institutional competition

From the point of view of the formal standards bodies, consortia are rivals. Consortia attract expertise from the group of large industrial companies which also contributes most of the expertise, technical contributions, organisational support, and of course funding to formal SDOs, thus raising the possibility that these resources are diverted to consortia or need to be increased overall (Hawkins, 1999). Moreover, companies interested in standardising their technology can choose which forum best serves their commercial needs: a formal standards body or a consortium. Such 'forum shopping' may occur based on the likely speed of standardisation, favourable IPR rules, the like-mindedness of participants, etc. In a pilot, Jakobs & Kritzner (2009) have made an effort to aid companies in assessing six standards settings against an elaborate list of criteria (i.e. the consortia OASIS, OMG, and W3C, and the formal bodies CEN/ISSS, ETSI and JTC1).
Where the desired forum does not yet exist, a new consortium can be founded. There are companies that specialise in setting up consortia.

Whether a higher pace of standardisation is guaranteed by consortia has not been corroborated convincingly. The extent to which consortia use streamlined methods, in particular moderating their requirements for consensus decision making, well-balanced representation of interest groups, etc., means that they may produce specifications more quickly than the formal bodies do (Rada 2000; CRE 2000). However, there are doubts about the shorter development period of consortium standards (Hawkins, 1999; Krechmer, 2000). An example is IETF's IPv6 which has taken more than a decade to finalise (Van Best, 2001). Moreover, as the OOXML case shows, a quick response may in some cases be a far less important factor than the actual type of agreement that is reached and how useful it is to the business models of stakeholders (Sherif, 2006).

Nevertheless, the standards procedures and speed of consortia like Internet's IETF were held up to the formal bodies as examples to be followed. Overall, consortia demonstrated the advantages of individual instead of national membership, of standards discussions carried out by electronic means, and of freely available and easily accessible final standards. The formal standards

bodies responded to the pressure of competition by broadening their range of services and introducing new procedures. Many of them have significantly reduced the development time and introduced the Publicly Available Specification procedure, which, as we saw, allows fast tracking of consortium specifications through the formal process. Some formal standards bodies such as ISO and the European CEN/CENELEC have extended their services to include more informal standardisation processes that lead to Workshop Agreements.

Conversely, over the years the procedures of standards consortia have also been adapted. The procedures of the consortia and those of the formal standards bodies show 'institutional homogeneity' (Bunduchi et al., 2008), in other words they have become increasingly similar. Possible reasons are that this similarity heightens the credibility of consortia as responsible standards organisations. In addition, consortia that want to feed their standards into a formal standards process via a fast-track or PAS procedure, must conform to the latter's ground rules for 'open standards making' (e.g. open membership and due process).

Interestingly, both formal standards bodies and standards consortia have been accused of 'rubber-stamping', that is of too easily ratifying externally developed specifications. For example, W3C has a 'member submission process' that makes it possible for W3C to consider proposals developed outside of the W3C. Although W3C rules explicitly state that this process is "not a means by which Members ask for 'ratification' of these documents as W3C Recommendations", W3C has in the past been accused of rubberstamping the products of major vendors via this process (Rada, 2000 p.22). In the past, a similar complaint has been made, for example, about the ITU (Besen & Farrell, 1991).

Whether institutional homogeneity increases competition between the two standards development settings, or actually decreases it - e.g. because the 'royal route' to a formal standard might lead to what many see as a higher-status standard - is a matter for further debate and research.

In recent years the complementarity of standards-setting environments has gained relevance. The question as to 'which setting is better' has shifted somewhat towards 'which setting is to be preferred under what circumstances'. Moreover, the two settings collaborate in certain areas (e.g. in ITU workshops and 3GPP), and formalise their relationships in liaison agreements and common interest groups. For example, the European ICT Standards Board, which aims "to coordinate the standardisation activities in the field of ICT (...)" and "to support an effective European standardisation system" comprises the three European Standardisation Organisations, CEN, CENELEC and ETSI and other specification-providing organisations with a presence in Europe, such as the European Broadcasting Union (EBU), Ecma International, the Organisation for the Advancement of Structured Information Standards (OASIS), the Internet Society (ISOC-ECC), and the World Wide Web Consortium (W3C).

ISO Standards development process and deliverables

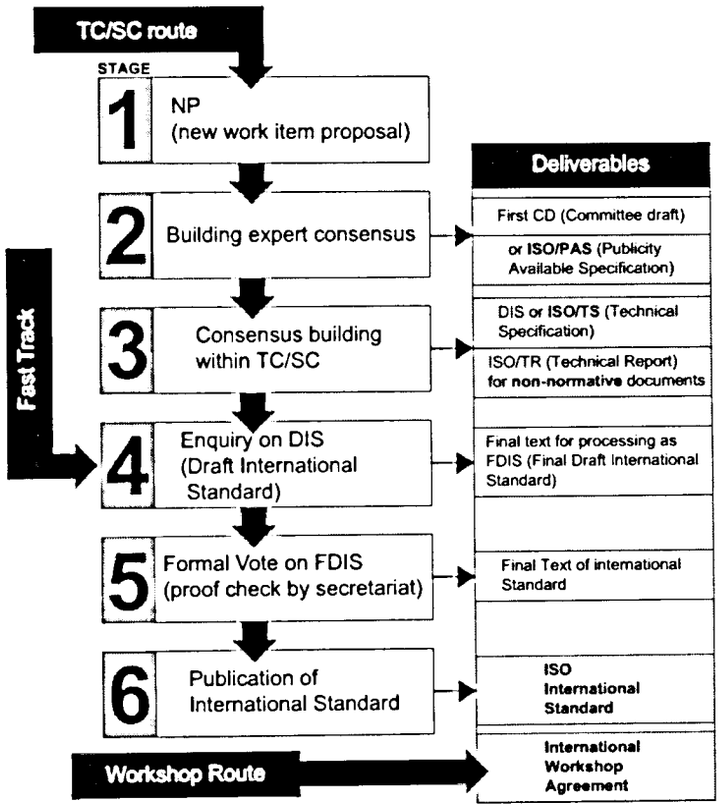


Figure: ISO/PAS Procedure (© pro-norm)

5.2 Democratic deficit of consortium standards

If the European and US situation can be generalized, many governments have difficulty dealing with consortium standards. For example, in Article 14 of the Council Resolution of 28 October 1999 on the role of standardisation in Europe, the European Commission is requested to examine how the European Union should deal with specifications that do not have the status of formal standards. The Council's feeling is that there may be a need to deal differently with consortium standards than with formal ones, a feeling which, for example, the US government shares (CRE, 2000). The CRE report is most explicit about what the problem is. It notes that consortia are undemocratic, which is a cause of concern for governments if they are to refer to such standards in a regulatory

or public procurement context. To do so requires a politically legitimate and democratically accountable standards process.
The present situation in Europe illustrates the issues at hand. In 1985 the European Union drew up the New Approach (see Chapter..). This approach entails that, where necessary, European legislation refers to technical specifications developed or accredited by the European standards bodies. By not including detailed standards in legislation, continuous revisions of legislation can be avoided. EU legislation and tenders for public procurement will preferably refer to formal standards because the latter are allegedly developed in standards bodies that have a 'democratic' and accountable decision-making culture (Werle & Iversen, 2006).
The historical reciprocal dependence of the EU on SDOs has solidified a strong alliance between them. In many cases, consortia disrupt this alliance. Even where consortia address very relevant areas of technology in a more efficient way, it is more difficult for government agencies to set up politically accountable alliances. This tension is illustrated by two recent conclusions of the Council of the European Union (2008, conclusions 23 and 24). The Council

"(...)TAKES THE VIEW that it would be helpful for European standardisation bodies to exploit possible synergies with standardisation fora and consortia and RECALLS its preference for making the transformation of informal normative documents into formal standards through the recognised standardisation bodies conditional on an evaluation of market needs, the carrying out of a public enquiry and the search for consensus among all interested parties;
POINTS OUT that the desired acceleration of the standardisation process must not take place to the detriment of the principles of quality, transparency and consensus among all interested parties (...)"

In reality there are very few instances in which European legislation would reference ICT standards (DLA Piper, 2007). Where government is concerned, the public procurement context is much more relevant although less prominent in the discussion. The European government market for IT procurement is sizable. Governments will want to avoid wasting public expenses and market distortion that might stem from referencing 'undemocratic' standards.

Whereas in earlier years, the consortia problem was framed in terms of 'consensus versus speed', more recently it is discussed in terms of 'open standards'. The governments' 'consensus' criterion for accountable standards-making is being overtaken by the 'openness' criterion. The question has now become: What is an open standard? (Krechmer, 2009; Schoechle, 2009) At least, open standards are developed in an 'open', that is democratically accountable, environment. See the chapter "ICT Standardisation - a primer". If consortia can argue that they have such a process in place, this would open up the path towards full acknowledgement of consortium standards by governments.

Aspects of the consortium problem as defined in the dominant rhetoric and the proposed redefinition

	Aspect of the consortium problem	as defined	as redefined
1	Standardisation setting characterised as	area of (democratic) regulatory governance	fair market competition
2	democratic standards process · compatibility standards · health/safety/ environmental/etc standards	consensus, well-balanced participation	· multi-party & simple majority voting (if no judical status, no criterion) · consensus, well-balanced participation
3	approach to consortia	general	differentiated
4	aim of technical coordination	standardisation	compatibility
5	stage of standardisation emphasised	standards development	standards diffusion and implementation
6	stage of technical development emphasised	technology research and development	technology diffusion in market

Figure: Aspects of the consortium problem as defined in the dominant rhetoric and the proposed redefinition (Source: Egyedi, 2006, p. 102)

5.3 Proliferation of standards

What we might consider to be the 'cost-benefit' or 'gain-loss' dynamics of consortia can be explained better by looking at how standards interact with markets. Basically, whether established by agreement or practice, every standard creates a market for goods conforming to that standard. But efficiency declines if there are too many standards (markets) for goods of comparable utility (i.e. goods that do not have to be differentiated in order to serve their basic function).
Not every standardisation initiative automatically has the effect of facilitating the creation of new markets. If standardisation is left entirely to the market, oligopolistic forces might intervene to impose standards that limit the generation of new markets. Thus, the rationale for institutional intervention appears, such as we see embodied in SDOs and, indeed, in consortia. Especially in the kinds of rapidly developing product and service environments that we can see in the ICT sectors, the balance between gains from coordination and gains

from diversity can be extremely fine, and can vary substantially from one (even very small) segment of the market to another.
We might propose that consortia sit on this edge. They may offer gains in efficiency regarding specific parts of a market, but, as in a networked environment where many things have to work together, the proliferation of consortia outputs may create a much larger general coordination problem with its associated costs. Added efficiency in development can be counterbalanced by loss of efficiency in application due to added coordination costs.

Many now regard consortia to be a problem because of the costs of monitoring the more than 230 instances of them, the costs of multiple memberships, and the costs of overlap and incoherence between competing standards (Cargill & Bohlin, 2007). These costs are mainly carried by industry - as standards developers and users - but, in the case of interoperability problems, also by the end-users, the consumers. There is no central independent agency to coordinate the outputs of standards-setting bodies. This has been identified as a problem by both government and industry.

Interface, Interoperability Problems

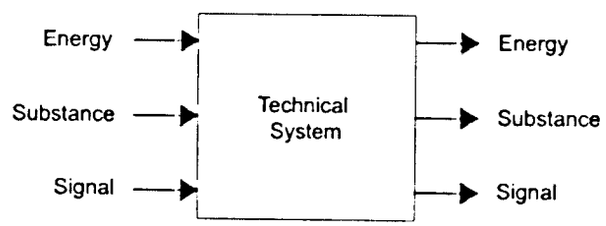


Figure: Interface, Interoperability Problems (Source: Pahl & Beitz 1993, p. 36)

6 Discussion

Most developers and users of ICT standards will consider it irrelevant whether standards come from a consortium or a formal standards body as long as the standardisation process takes their interests on board, and the standard itself creates a level playing field for companies, makes the market more trans-parent, and fosters interoperability. During the past decade, however, a polarized discussion has emerged about whether consortia and consortium standards could answer these needs more effectively albeit less democratically than the formal stan-dards bodies ('consensus versus speed' debate).

The ambiguities that underlie this debate are the diversity among types of consortia; un-specified use of the term 'democracy'; the previously unaddressed gap between written standards procedures and actual processes in consortia as well as formal standards bodies; and the institutional changes which both standards-setting environments have undergone during the past decade (i.e. is the discussion relying too much on 'historical' studies?). At present, the arguments on both sides seem gross generalisations and not always to the point. As the document standards war illustrated, of what use is a rapidly developed consortium standard if its quality is so low that no one would want to implement it? And of what use are the democratic procedures of a formal standards body if an immature consortium standard is fast-tracked, thereby by-passing the more thorough and democratic process?
Not only is too much value placed on the written procedures of both consortia and the formal standards bodies, but also too little thought has been spent on whether or not the type of democracy propagated in formal standardisation (i.e. based on national interest) is tenable in the field of ICT, where multinationals, firstly, have more focused interests and, secondly, many more resources to advance these interests than many countries. Indeed, the economies of countries may depend to a great extent on support from these companies. This tension may call for a different kind of standards setting altogether. As a first step, sustained ambiguity about what is meant by 'democratic' procedures needs to be resolved (Schoechle, 2009). Clarity is needed on whether politically accountable procedures are really only needed for standards that are instruments of regulatory governance - which are exceptional in the field of ICT - or whether they are also needed in other circumstances. Andy Updegrove makes the case that civil ICT standards, that is standards with a high public interest, should also fall under such a regime (Updegrove, 2008). For example, standards for document formats would fall within this scope because citizens need to exchange and have access to information with their government.
At present the standards-setting arena is very diverse, ranging from de facto proprietary standards to closed consortia agreements, workshop agreements facilitated by the formal standards bodies, consortium standards, formalised consortium standards and formal standards. Each represents a different degree of market coordination and associated level of credibility and legitimacy.
Perhaps most importantly, the current discussion about 'open versus closed standards' may signify a rising awareness that the difference between the closed, proprietary de facto standards and multi-party committee standards is much greater than the difference between formal committee standards and consortium standards (Egyedi, 2006). Policy is needed to support this awareness and take the issue beyond 'consortia versus formal standardisation' towards the benefits of committee standardisation.

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8 Glossary

ANSI
American National Standards Institute

American Petroleum Institute (API)
The American Petroleum Institute, commonly referred to as API, is the main U.S trade association for the oil and natural gas industry, representing about 400 corporations involved in production, refinement, distribution, and many other aspects of the industry. The association's chief functions on behalf of the industry include advocacy and negotiation with governmental, legal, and regulatory agencies; research into economic, toxicological, and environmental effects; establishment and certification of industry standards; and education outreach. API both funds and conducts research related to many aspects of the petroleum industry.

American Society for Testing and Materials (ASTM)
ASTM International (ASTM), originally known as the American Society for Testing and Materials, is an international standards organisation that develops and publishes voluntary consensus technical standards for a wide range of materials, products, systems, and services. The organization's headquarters is in West Conshohocken, Pennsylvania, about 5 miles northwest of Philadelphia.
ASTM predates other standards organisations such as BSI (1901), DIN (1917) and AFNOR (1926), but differs from these in that it is not a national standards body, that role being taken in the USA by ANSI. However, ASTM has a dominant role among standards developers in the USA, and claims to be the world's largest developer of standards. Using a consensus process, ASTM supports thousands of volunteer technical committees, which draw their members from around the world and collectively develop and maintain more than 12,000 standards.
ASTM International publishes the Annual Book of ASTM Standards each year in print, CD and online versions. The online version was available by subscription and cost was based upon usage. For 2008, the complete set of books or CDs cost almost USD $9000 and included 81 volumes.

ANSI-accredited
ANSI, the "umbrella organization" of the private US standardization system, accredits those private US standardization organizations which meet "ANSI Essential Requirements". The requirements are subsumed under the term "due process" and encompass aspects such as consensus-orientation, a public inquiry stage, the consideration of public comments and an appeals process. See for example ANSI (2009): Introduction to ANSI. http://www.ansi.org/about_ansi/introduction/introduction.aspx?menuid=1, 31.07.2009.

Antagonists
An antagonist is a character, group of characters, or an institution, who represents the opposition against which the protagonist(s) must contend.

API Standards
An application programming interface (API) defines how an application program and an operating system interact. A standardized API (or standardised elements thereof) would provide one single development environment and would allow one program to be run on various platforms without any (or minor) modifications. Standardisation is not especially advanced in this field at present, as various different APIs exist for different platforms such as operating systems, web services and the like.

Application Consortia
According to Weiss & Cargill (1992), application (and implementation) consortia focus on the usability of existing standards or formalise de facto standards or well-established practices. See Weiss, M. & Cargill, C. (1992): Journal of the American Society for Information Science 43(8), 559-565.

Article 14 of the Council Resolution of 28 October 1999
In Article 14 of the Council Resolution of 28 October 1999 on mutual recognition the council "calls upon the Member States to continue to develop appropriate measures, including the following, in order to provide economic operators and citizens with an effective framework for mutual recognition".

ATM Forum
The ATM Forum was founded in 1991 to be the industry consortium for Asynchronous Transfer Mode. It was a non-profit international organisation. In its day, the ATM Forum was a vigorous industry body, creating over 200 implementation agreements.
ATM technology stabilised with the "Anchorage Accord", which established the baseline of ATM implementations. While ATM did not live up to every expectation, it remains an important core network technology. In 2004, the ATM Forum joined forces with the MPLS & Frame relay alliance to form the MFA Forum. The MFA Forum later merged with the IP/MPLS Forum and in 2008 with the Broadband Forum.

Bull
Bull is a French computer company that was founded in 1931 and is headquartered in Les Clayes-sous-Bois.

CEN/ISSS
The CEN Information Society Standardisation System (CEN/ISSS) was set up by CEN in 1997 in order to provide a less formal standardisation approach in the field of Information and Communications Technologies (ICT). CEN/ISSS Workshops prepare "CEN Workshop Agreements" (CWA) in a less formal fashion as compared to the preparation of "regular" European Standards. See the CEN-CENELEC ICT Forum (http://www.cen.eu/cenorm/businessdomains/businessdomains/isss/about_isss/index.asp) for details.

Center for Regulatory Effectiveness
The Center for Regulatory Effectiveness (CRE) is a lobby group in the United States which focuses on federal agency compliance with "good government" laws which regulate the regulators. These "good government" laws include the Data Quality Act, the Paperwork Reduction Act, Executive Orders on regulatory review, the Unfunded Mandates Act, the Regulatory Flexibility Act and the Congressional Review Act.

Closed standards
Closed standards, as opposed to open standards, are standards to which only "a chosen few" have access, whereas other interested parties perceive a closed standard as a black box. In the extreme case, one single agent (usually a firm) keeps its (de facto) standard undisclosed to the public in order to exploit it economically and to maintain its monopolistic market position.

Committee standardisation
Umbrella term for any cooperative, consensus-based approach to standards preparation. It encompasses standardisation both in formal standards bodies as well as consortia and fora.

Consensus principle
General agreement, characterised by the absence of sustained opposition to substantial issues by any important part of the concerned interests, and by a process that involves seeking to take into account the views of all parties concerned and to reconcile any conflicting arguments (ISO/IEC Guide 2:2004, EN 45020:1998, 1.7, CEN/BOSS Glossary: http://www.cenorm.be/BOSS/glossary.asp). Consensus need not imply unanimity.

Consensus versus speed
One of the fundamental dilemmas/conflicts of objectives in standardisation: Consensus is a core element of the basic principles of standardisation and provides a standard with legitimacy as well as a broad acceptance among its user base. To reach a consensus is time-costly, however, which is in conflict with the need for speedy standards preparation in many fast-moving technology fields and markets. The challenge in standardisation is to speed up standards preparation on the one hand and to keep up with the consensus principle on the other hand.

Consortia standards, consortia agreement
Normative deliverables such as technical specifications or publicly available standards consortia prepare and publish, to be distinguished from acknowledged standards.

Cost-benefit
In a market-based society the comparison of costs and benefits (or cost-benefit analysis, in a stricter sense of the term) provides a fundamental feasibility criterion. Any economic activity is only viable in the long run if the benefits (usually defined in monetary terms) exceed the costs in the long run.

CRE report
Center for Regulatory Effectiveness (2000). Market-Driven Consortia, Implications for the FCC's Cable Access proceeding, see www.thecre.com/pdf/whitepaper.pdf.

De facto proprietary standards
A standard in which an agent (e.g. a firm or a consortium) holds implicit ("de facto") property rights.

Democracy in formal standardization
Formal standardisation draws its democratic legitimation from adhering to the principles of due process/the basic principles of standardisation. As laid down by the DIN fundamentals of standards preparation ("Grundlagen der Normungsarbeit") these principles encompass
- voluntary basis of participation and standards usage,
- open book,
- open door,
- uniformity and consistency of the standards repository,
- the consensus principle as the prevailing decision-making mechanism,
- technological state of the art,
- primacy of public interest, and
- primacy of international standardisation.

Democracy
Democracy is a form of government in which the right to govern is vested in the citizens of a country or a state and exercised through a majority rule. It is derived from the Greek δημοκρατία (dēmokratía (info)), "popular government", which was coined from δῆμος (dêmos), "people" and κράτος (krátos), "rule, strength" in the middle of the fifth-fourth century BC to denote the political systems then existing in some Greek city-states, notably Athens following a popular uprising in 508 BC. A democracy can denote either direct or indirect rule by the people.

Democratic Procedures
In standardisation, democratic procedures are largely identical with the notion of "due process"
(see e.g. http://www.ansi.org/about_ansi/introduction/introduction.aspx?menuid=1) or the basic principles of standardisation which encompass e.g. primacy of public interest, openness, consensus and the voluntary use of a standard. Democratic procedures in standardisation entail democratic legitimation and ensure the broad use of a standard by all interested parties.

Ecma, European Computer Manufacturers Association
Ecma International (Ecma) is an international, private (membership-based) non-profit standards organisation for information and communication systems. It acquired its name in 1994, when the European Computer Manufacturers Association (ECMA) changed its name to reflect the organisation's international reach. As a consequence, the name is no longer considered an acronym and no longer uses full capitalisation.

ECMA 372
C++/CLI Language Specification
This standard specifies requirements for implementations of the C++/CLI binding. The first such requirement is that they implement the binding, and so this standard also defines C++/CLI. Other requirements and relaxations of the first requirement appear at various places within this Standard.
C++/CLI is an extension of the C++ programming language as described in ISO/IEC 14882:2003, Programming languages – C++. In addition to the facilities provided by C++, C++/CLI provides additional keywords, classes, exceptions, namespaces, and library facilities, as well as garbage collection.

ECMA Committees
Technical Committees, such as TC31 - Optical disks and disk cartridges, in which ECMA standards are prepared.

European Broadcasting Union (EBU)
The European Broadcasting Union (EBU; French: Union européenne de radio-télévision (UER)) is a confederation of 75 broadcasting organisations from 56 countries, and 43 associate broadcasters from a further 25. It is unrelated to the European Union. Members are radio and television companies, most of which are government-owned public service broadcasters or privately owned stations with public missions. Full active Members are based in countries from Algeria to the Vatican State, including almost all European countries. Associate members are not limited to those from European countries and the Mediterranean but include broadcasters from Canada, Japan, Mexico, India and Hong Kong, as well as many others. Associate Members from the United States include ABC, CBS, NBC, the Corporation for Public Broadcasting, and Time Warner.

European standards bodies, European standardisation bodies
The formal European standards bodies which are acknowledged by the EU and which play a pivotal role in the European standardisation policy, i.e.:
- European Committee for Standardization (CEN)
- European Committee for Electrotechnical Standardization (CENELEC)
- European Telecommunications Standards Institute (ETSI).

Formal committee standards
Formal committee standards are standards which are prepared according to the principles of "due process"/the basic principles of standardisation in Technical Committees under the aegis of a formal standards body such as DIN, CEN or ISO. In particular, formal committee standards differ from normative documents that consortia publish by, for example, exhibiting a higher degree of legitimacy.

Formal international standards system
The formal international standards system encompasses the International Organization for Standardization (ISO), the International Electrotechnical Commission (IEC), and the International Telecommunication Union (ITU).

Formal standards bodies
Formal standards bodies exhibit a number of institutional similarities and prepare standards according to the principles of "due process"/the "basic principles of standardisation". Formal standards bodies are in most if not all cases acknowledged by the state or supranational governmental bodies such as the EU (which has acknowledged the European standards Bodies CEN, CENELEC and ETSI) as partners in matters such as in regulative affairs and legislation and are granted specific rights (e.g. the right to represent a national standardisation system on the international level or financial support). International formal standardisation bodies are indirectly acknowledged by the states which participate in international standardisation and apply international standards, and the World Trade Organization (WTO) which refers to international standards in its efforts to liberalise international trade.

Formal standards process
Despite different working fields and geographic domains, formal standards bodies bear many institutional similarities. Standards preparation is not only carried out according to a number of basic principles ("due process", "basic principles of standardisation"), but also adopts a similar process. At ISO a standard goes through the proposal stage, the preparatory stage, the committee stage, the enquiry stage, the approval stage and the publication stage (see:http://www.iso.org/iso/standards_development/processes_and_procedures/stages_description.htm). This sequence of "production stages" is characteristic for most if not all formal standards bodies.

Forum shopping
Given the plethora of standards developing organisations (formal standards bodies, fora, consortia, etc.) in working fields like ICT, firms can increasingly choose from a broad range and pick that SDO which suits their interests best (e.g. in terms of the given IPR regime, membership structure or standards preparation speed). This behaviour is called forum shopping.

Gain-loss
A loss of profit, or more precisely: a reduced or negative profit growth rate.

Higher-status standard
A standard that ranks higher in one or more respects, as compared to other standards. E.g. formal standards have a higher degree of legitimation as compared to consortia standards and can be more readily applied in legal or regulatory contexts.

IBM
International Business Machines Corporation, abbreviated IBM and nicknamed "Big Blue" (for its official corporate colour), is a multinational computer technology and IT consulting corporation headquartered in Armonk, New York, United States. The company is one of the few information technology companies with a continuous history dating back to the 19th century. IBM manufactures and sells computer hardware and software, and offers infrastructure services, hosting services, and consulting services in areas ranging from mainframe computers to nanotechnology.

ICT standardisation
All standardisation activities carried out in the field of Information and Communications Technology.

ICT standards system
The set of all ICT-related standards in a geographic domain and their interrelations.

IEC
The International Electrotechncial Commission.
http://www.iec.ch/about/partners/agreements/etsi-e.htm.

IEEE Standards
Standards published by the Institute of Electrical and Electronics Engineers/ IEEE Standards Association. The IEEE is an eminent standards-setter and has produced a number of internationally established standards such as the IEEE 802.11 standards family for wireless local area networks (WLAN).

IPv6
The Internet Protocol version 6 (IPv6) was published by the Internet Engineering Task Force in 1989 and was devised in the first place to replace the Internet Protocol version 4 which is still widely used but suffers from a shortage of Internet Protocol addresses.

Implementation
Implementation is the realisation of an application, or execution of a plan, idea, model, design, specification, standard, algorithm, or policy.
In computer science, an implementation is a realisation of a technical specification or algorithm as a program, software component, or other computer system. Many implementations may exist for a given specification or standard. For example, web browsers contain implementations of World Wide Web Consortium-recommended specifications, and software development tools contain implementations of programming languages.
In the IT Industry, implementation refers to the post-sales process of guiding a client from purchase to use of the software or hardware that was purchased. This includes requirements analysis, scope analysis, customizations, systems integrations, user policies, user training and delivery. These steps are often overseen by a Project Manager using project management methodologies set forth in the Project Management Body of Knowledge. Software implementations involve several professionals that are relatively new to the knowledge based economy such as Business Analysts, Technical Analysts, Solutions Architects, and Project Managers.
In political science, implementation refers to the carrying out of public policy. Legislatures pass laws that are then carried out by public servants working in bureaucratic agencies. This process consists of rule-making, rule-administration and rule-adjudication. Factors impacting implementation include the legislative intent, the administrative capacity of the implementing bureaucracy, interest group activity and opposition, and presidential or executive support.

Industry association
An industry association (or trade association) is an organisation that acts on behalf/in the interest of the firms of an industry. Industry associations exert influence on their environments, especially the political realm, regulators and legislators, which favours their clients.

Institutional Homogeneity
The term 'institutional homogeneity' denotes the phenomenon that most standards-developing organisations, i.e. not only formal standards bodies, but also consortia and fora, exhibit many institutional similarities, e.g. regarding basic organisational attributes or the characteristics of the standardisation process.

Internet Society (ISOC-ECC)
The Internet Society or ISOC is an international, nonprofit organisation founded in 1992 to provide leadership in Internet related standards, education, and policy. It states that its mission is "to assure the open development, evolution and use of the Internet for the benefit of all people throughout the world".
The Internet Society has offices near Washington, DC, USA, and in Geneva, Switzerland. It has a membership base comprising more than 80 organisational and more than 28,000 individual members. Members also form "chapters" based on either common geographical location or special interests. There are currently more than 90 chapters around the world.

Interoperability Problems
Any unintended dysfunction in the interoperation of technical systems, i.e. in the exchange of matter, energy and signals.

ISO System
A general term for ISO's basic attributes such as organisational structure, membership structure, procedures, strategies and policies. See http://www.iso.org/iso/about/discover-iso_isos-name.htm for details.

ISO/IEC 2630
ISO/IEC 26300:2006 defines an XML schema for office applications and its semantics.
The schema is suitable for office documents, including text documents, spreadsheets, charts and graphical documents such as drawings or presentations, but is not restricted to these kinds of documents.
ISO/IEC 26300:2006 provides for high-level information suitable for editing documents. It defines suitable XML structures for office documents and is friendly to transformations using XSLT or similar XML-based tools.
ISO/IEC 26300:2006 first provides an introduction to the OpenDocument format and explains the structure of documents that conform to the OpenDocument specification. It describes the meta information that can be contained in such documents, and their text and paragraph content. Text fields and text indices are described.
ISO/IEC 26300:2006 describes the table content of a document in OpenDocument format, its graphical content, its chart content and its form content. It also describes content that is common to all documents. It describes the integration of SMIL animation markup into the OpenDocument schema. It explains style information content and specifies formatting properties that can be used within styles. The data types used by the OpenDocument schema are described. The OpenDocument format makes use of a package concept; these packages are described.

ISO/IEC 29500
ISO/IEC 29500: Information technology - Document description and processing languages - Office Open XML File Formats. This is basically Microsoft's Office Open XML specification that was fast-tracked under controversial circumstances by the Joint Technical Committee (JTC1) of ISO/IEC in 2008 to become a "regular" ISO/IEC standard.

IT procurement
This term denotes the planning and management of the purchase of IT equipment, software and services by (large) firms and especially the government/ government agencies. Procurement procedures follow specific rules to ensure that certain criteria like cost-effectiveness, a fair and non-discriminatory bidding process or ecological and safety standards are being met.

JTC1, Joint Technical Committee 1
JTC1 is a Joint Technical Committee 1 of ISO and IEC that is active in the field of information technology. JTC1 by and large exhibits the same institutional attributes (rules of procedure, membership structures, etc.) as its parent organisations. JTC1 gained some public prominence in 2008 when it fast-tracked Microsoft's Office Open XML specification under controversial circumstances.

JPEG
In computing, JPEG is a commonly used method of compression for photographic images. The degree of compression can be adjusted, allowing a selectable tradeoff between storage size and image quality. JPEG typically achieves 10:1 compression with little perceptible loss in image quality.
JPEG compression is used in a number of image file formats. JPEG/Exif is the most common image format used by digital cameras and other photographic image capture devices; along with JPEG/JFIF, it is the most common format for storing and transmitting photographic images on the World Wide Web. These format variations are often not distinguished, and are simply called JPEG.

Microsoft
Microsoft Corporation is a United States-based multinational computer technology corporation that develops, manufactures, licenses, and supports a wide range of software products for computing devices. Headquartered in Redmond, Washington, USA, its most profitable products are the Microsoft Windows operating system and the Microsoft Office suite of productivity software.

Microsoft applications
Microsoft application programs like MS Office, as opposed to Microsoft operating systems like Windows XT or Vista.

MPEG, Moving Picture Experts Group
The Moving Picture Experts Group was formed by the ISO to set standards for audio and video compression and transmission. Its first meeting was in May 1988 in Ottawa, Canada. As of late 2005, MPEG has grown to include approximately 350 members per meeting from various industries, universities, and research institutions. MPEG's official designation is ISO/IEC JTC1/SC29 WG11.

Multi-party committee standards
This term denotes committee standards which have been cooperatively prepared by a multitude of (if not all) interested parties, as opposed to closed or proprietary standards.

National membership
In regional and international standards bodies like CEN or ISO only national standards bodies are eligible for full membership. The interested parties are represented by delegations, which national standards bodies dispatch and put forth their national positions on the regional or international level. Given this indirect representation of individual interests, the national membership principle in regional and international standards bodies has frequently been criticised for violating democratic principles.

Networked environment
An entity (individual, organisation or technical system) which can refer to one or more networks to access resources and services to perform its tasks operates in a networked environment.

OASIS
Organization for the Advancement of Structured Information Standards

ODF
The OpenDocument Format is - just like Microsoft's OOXML format - an XML-based file format (XML: Extensible Markup Language) for the representation of spreadsheets, charts, presentations and text documents. Originally specified by Sun Microsystems it became an OASIS standard (OASIS: Organization for the Advancement of Structured Information Standards) in 2005 and an ISO/IEC standard in 2006 (ISO/IEC 26300:2006 Open Document Format for Office Applications (OpenDocument) v1.0). The OpenDocument Format competes with Microsoft's OOXML format which is also an ISO/IEC standard (ISO/IEC 29500:2008).

OOXML
Originally developed by Microsoft, Office Open XML (OOXML, XML: Extensible Markup Language) is a file format for the representation of spreadsheets, charts, presentations and text documents. Microsoft submitted its OOXML specification to ECMA International where it became an ECMA standard (ECMA-376). This standard was then submitted to the Joint Technical Committee 1 of ISO and IEC

to be fast-tracked to become an ISO/IEC standard in 2008 (ISO/IEC 29500:2008). This, however, did not proceed perfectly smoothly and Microsoft was criticised from various sides for abusing and manipulating the ISO/IEC standardisation process (an accusation to which Microsoft admits to some degree; see e.g. http://news.zdnet.co.uk/software/0,1000000121,39288959,00.htm for details) and for submitting a poor (if not bad) draft specification.

Open Networks
Open networks are networks (or some services thereof) to which all users have equal access.

Oracle
Oracle Corporation is a California-based software firm which was founded in 1977 and develops enterprise software (e.g. its "Oracle database" or enterprise resource planning software).

Protagonists
A protagonist is the main character (the central or main figure) of a drama or story. The word "protagonist" derives from the Greek πρωταγωνιστής (protagonistes), "one who plays the first part, chief actor."[1] In the theatre of Ancient Greece, three actors played all of the main dramatic roles in a tragedy; the leading role was played by the protagonist, while the other roles were played by deuteragonist and the tritagonist.

Public procurement regime
The rules according to which procurements are being made in governments, government agencies and public bodies.

Publicly available standards
Umbrella term for standards prepared and published by consortia and fora and that are open to the public/all interested parties (to be distinguished from formal standards).

Questions
Questions are high-level working areas into which the standarisation activities of the ITU-T are structured.

R&D, Research and Development
The phrase research and development (also R and D or, more often, R&D), according to the Organization for Economic Co-operation and Development, refers to "creative work undertaken on a systematic basis in order to increase the stock of knowledge, including knowledge of man, culture and society, and the use of this stock of knowledge to devise new applications".

Regional development
Regional development is the provision of aid and other assistance to regions which are less economically developed. Regional development may be domestic or international in nature. The implications and scope of regional development may therefore vary in accordance with the definition of a region, and how the region and its boundaries are perceived internally and externally.

Regulation
Usually performed by the government or government agencies, the term 'regulation' denotes the activity of influencing or directing human behaviour in a society according to some set of socioeconomic goals. According to these goals a set of rules and incentives is introduced to encourage/prescribe favourable behaviour patterns and to discouraged/forbid detrimental behaviour patterns.

Rubber-stamping
A rubber stamp, as a political metaphor, refers to a person or institution with de jure considerable formal power but little de facto power, one that rarely disagrees with more powerful organs. For example, in a dictatorship, the legislature may be little more than a "rubber stamp" of approval on the dictator's decrees. Conversely, in a constitutional monarchy, the monarch is typically a "rubber stamp" to an elected parliament, even if he or she legally possesses considerable reserve powers and/or disagrees with the parliament's decisions.

SDOs, Standards developing organisations
The term 'SDO' denotes 'formal' standards bodies such as ITU and ISO.

SDO committees, standards developing organisations committees
Standards committees (or technical committees) form an organisational core element in standards-developing organisations. In formal standards bodies, for example, technical committees consist of experts who voluntarily participate in standards preparation. Technical committees furthermore feature a chairman, who functions in the first place as a mediator, and are supported by a secretariat. Decision-making mechanism of choice is the consensus principle, qualified majority voting only a last resort.

SDO system
Entirety of all SDOs, i.e. formal standards bodies, consortia, fora, government agencies and other organizations active in standards preparation.

Service environments
The set of services an entity (e.g. a customer, company or a technical system such as a mobile phone or a computer) can call on to support its activities or to perform a specific task.

Specifications
A specification is an explicit set of requirements to be satisfied by a material, product, or service. Should a material, product or service fail to meet one or more of the applicable specifications, it may be referred to as being out of specificiation; the abbreviation OOS may also be used.
A technical specification may be developed privately, for example by a corporation, regulatory body, military, etc: it is usually under the umbrella of a quality management system. Specifications can also be developed by standards organisations which often have more diverse input and usually develop voluntary standards: these might become mandatory if adopted by a government, business contract, etc.

Stakeholders
Stakeholders are entities that hold an interest in or are in one way or another affected by standardisation or specific standards. Stakeholders are for example consumers, users, companies, NGOs, unions, researchers, the state, or the military.

Standardisation ideology
The term 'standardisation ideology' refers to shared ideas on how standardisation should proceed, beliefs on what is important in the process of establishing standards and why it is important, assumptions about the standards environment, etc. embedded in the structure and procedures of standards bodies.

Standards body
The term 'standards body' denotes every entity which develops (or coordinates the developments of) standards and maintains standards and standards repositories. The term is in the first place used to denote formal (or acknowledged) national, regional and international standards bodies but may also apply in the case of standards developing organisations like consortia or fora.

Standards committees
Standards committees (or technical committees) form an organisational core element in standards-developing organisations. In formal standards bodies, for example, technical committees consist of experts who voluntarily participate in standards preparation. Technical committees feature a chairman, who functions in the first place as a mediator, and are supported by a secretariat. Decision-making mechanism of choice is the consensus principle, qualified majority voting only a last resort. In SDOs, (technical) committees form an organisational core element. In formal standards bodies, for example, technical committees consist of experts who voluntarily participate in standards preparation. Technical committees have a chairman, who functions as a mediator, and are supported by a secretary.

Standards consortium
In the narrowest sense, the term 'standards consortium' refers to an alliance of companies and/or organisations that aims to develop publicly available standards or technical specifications for the purpose of coordinating technology and market development in a specific ICT area.
In the wider sense, the term standards consortium refers to all non-formal standards organisations that develop publicly available standards or technical specifications for the purpose of coordinating technology and market development activities.

Standards procedures
Set of institutional rules which standards bodies apply to transform certain inputs - knowledge and preferences the relevant agents have about the design of a standard - into certain outputs, i.e. standards and related normative documents. Standards procedures are laid down in the rules of procedures and statutes of standards bodies.

Standards process
A standards process is a sequence of events and actions by the relevant agents under the domain of a standards body which eventually leads to the completion and publication of a standard.

Strategic consortium
A strategic consortium is a standards consortium with distinct strategic goals which are usually economic by nature and might well go beyond mere standards preparation.

Strategic interests
Strategic interests in standardisation are long-term by nature, might well go beyond mere standards preparation and are usually directed towards market success. For example, it is the strategic interest of a firm to influence standards preparation in various standards bodies in such a way that its dominant market position remains unchallenged in the long run.

Sun Microsystems
Sun Microsystems, Inc. is a multinational vendor of computers, computer components, computer software, and information technology services, founded on February 24, 1982. The company is headquartered in Santa Clara, California (part of Silicon Valley), on the former west campus of the Agnews Developmental Center.
Products include computer servers and workstations based on its own SPARC processors as well as AMD's Opteron and Intel's Xeon processors; storage systems; and, a suite of software products including the Solaris Operating System, developer tools, Web infrastructure software, and identity management applications. Other technologies of note include the Java platform, MySQL

and NFS. Sun is a proponent of open systems in general and Unix in particular, and a major contributor to open source software.
On April 20, 2009, Sun and Oracle Corporation announced that they had entered into a definitive agreement under which Oracle would acquire Sun for $7.4 billion. Sun shareholders approved the acquisition on July 16, 2009, but the deal is still awaiting regulatory approval, with no date yet given for its completion.
Sun's manufacturing facilities are located in Hillsboro, Oregon, USA and Linlithgow, Scotland.

Technical specifications
In a general sense the term 'technical specification' denotes every normative document or technology which has the potential to become a standard, be it a formal standard, a consortium standard or a de facto standard. In a stricter sense, the term 'Technical Specification' refers to deliverables standards bodies like CEN and ISO have introduced to reduce time to market or to publish documents on which formal consensus has not yet been reached. See e.g. http://www.cen.eu/BOSS/production/production+processes+-+index/technical+specifications/technical+specifications.asp and http://www.iso.org/iso/standards_development/processes_and_procedures/deliverables/iso_ts_deliverable.htm for details on these deliverables.

Technical standards
Any standard that is technical in its scope

Tim Berners-Lee
Sir Timothy John Berners-Lee, (London, 8 June 1955), is an English engineer and computer scientist and MIT professor credited with inventing the World Wide Web, making the first proposal for it in March 1989. On 25 December 1990, with the help of Robert Cailliau and a young student staff at CERN, he implemented the first successful communication between an HTTP client and server via the Internet. In 2007, he was ranked Joint First, alongside Albert Hofmann, in The Telegraph's list of 100 greatest living geniuses. Berners-Lee is the director of the World Wide Web Consortium (W3C), which oversees the Web's continued development. He is also the founder of the World Wide Web Foundation, and is a senior researcher and holder of the 3Com Founders Chair at the MIT Computer Science and Artificial Intelligence Laboratory (CSAIL). He is a director of The Web Science Research Initiative (WSRI), and a member of the advisory board of the MIT Center for Collective Intelligence. In April 2009, he was elected as a member of the United States National Academy of Sciences, based in Washington, D.C.

US Anti-trust law
United States antitrust law is the body of laws that prohibits anti-competitive behaviour (monopoly) and unfair business practices. Antitrust laws are designed to encourage competition in the marketplace. [1] These competition laws make

illegal certain practices deemed to hurt businesses or consumers or both, or generally to violate standards of ethical behavior. Government agencies known as competition regulators, along with private litigants, apply the antitrust and consumer protection laws in the hope of preventing market failure. The term "antitrust" was originally formulated to combat "business trusts", now more commonly known as cartels. Other countries use the term "competition law". Many countries, including most of the Western world, have antitrust laws of some form; for example the European Union has provisions under the Treaty of Rome to maintain fair competition, as does Australia under its Trade Practices Act 1974.

US National Standards
Private standards developing organizations in the USA that adhere to the principles of "due process" (e.g. consensus-orientation, openness or balance of interests) and which have therefore been accredited by the American National Standards Institute are entitled to label their standards "American National Standards".

US standards bodies
Compared to the European standardisation system, the private, voluntary US standardisation system is a rather decentralised system with hundreds of independent organisations active in standards development. The American National Standards Institute (ANSI) stands out in being the foremost coordinating and administrating body within the private US standardisation system. ANSI, however, does not prepare standards itself but accredits US standards developing organisations which adhere to the principles of "due process" (e.g. consensus-orientation, openness or balance of interests). Prominent US standards developers are the American Institute of Electrical Engineers (IEEE), the American Society of Mechanical Engineers (ASME), the American Society for Testing Materials (ASTM International) or the National Institute of Standards and Technology (NIST). Notably, the U.S. Armed Forces and the US government are also eminent standards-setters.

Variety reduction
Variety reduction is one of the most immediate emanations of standardisation and a key instrument of rationalisation in production. Variety reduction results in a smaller product range and a reduced number of different parts used in production, thus enabling better plant utilisation, e.g. in the form of extended machine times/shorter changeover times, increased batch sizes and easier/more cost-effective warehousing - effects which all result in "economies of scale".

Vendors
A vendor, or a supplier, is a supply chain management term meaning anyone who provides goods or services to a company. A vendor often manufactures inventoriable items, and sells such items to a customer.

Voluntary application of standards
Voluntariness is a core element of the basic principles of standardisation, i.e. no-one is forced to participate in standards preparation or to apply a standard. Application of a standard may become mandatory, however, if the legislator refers to it in laws, or a (de facto) standard may become "de facto mandatory" because everybody else applies it.

Workshop Agreements
In order to shorten time to market and to offer consortia-style standardisation in a formal standards environment, CEN, CENELEC and ISO have introduced so-called "Workshops" and the related deliverables, "Workshop Agreements". At CEN, for example, "participation in a workshop will be open to anyone, non-Europeans being welcome, and the opportunity to participate will be widely advertised in advance by its proposers and by CEN and its member bodies." Workshop participants do not need to observe strict procedural rules to reach an agreement, as is the case in the preparation of European Standards. CEN merely asks "that the content of the Workshop Agreement should not conflict with existing European Standards." (For details see CEN (2009): Guidance - Characteristics of the CEN Workshop Agreement and CEN Workshop guidelines http://www.cen.eu/BOSS/supporting/guidance+documents/gd052+-+cwa+and+cen+workshop+guidelines/index.asp, (09.08.2009))

W3C, World Wide Web Consortium
The World Wide Web Consortium (W3C) is the leading organisation for the development of Web standards. In May 2009, the W3C had nearly 400 members.

3GPP
The 3rd Generation Partnership Project (3GPP) is a collaboration agreement that was established in December 1998.

3G and 4G Mobile Services
(3rd Generation) International Mobile Telecommunications-2000 (IMT-2000)
International Mobile Telecommunications-2000 (IMT-2000), better known as 3G or 3rd Generation, is a family of standards for wireless communications defined by the International Telecommunication Union, which includes GSM EDGE, UMTS, and CDMA2000 as well as DECT and WiMAX. Services include wide-area wireless voice telephone, video calls, and wireless data, all in a mobile environment. Compared to 2G and 2.5G services, 3G allows simultaneous use of speech and data services and higher data rates (up to 14.4 Mbit/s on the downlink and 5.8 Mbit/s on the uplink with HSPA+). Thus, 3G networks enable network operators to offer users a wider range of more advanced services while achieving greater network capacity through improved spectral efficiency.
(4th Generation) International Mobile Telecommunications-Advanced (IMT Advanced), better known as 4G, 4th Generation or Beyond 3G, is the next technological strategy in the field of wireless communications. A 4G system will upgrade

existing communication networks and is expected to provide a comprehensive and secure IP-based solution where facilities such as voice, data and streamed multimedia will be provided to users on an "Anytime, Anywhere" basis and at much higher data rates compared to previous generations (see QoS).

9 Key questions

- What is a standards consortium?
- What needs are standards consortia expected to meet?

Kai Jakobs

Abstract

This module provides a brief outline of the historical development of ICT standards. This is followed by a general overview of the ICT standardisation environment and its actors. The various types of actors are identified, as are the links that exist between them - or the lack thereof. A certain focus here is on the issue of cooperation vs. competition, including the current state of the art, and a discussion on how this situation could be improved. Subsequently, the characteristics of an 'open' standard are discussed. The last chapter provides more in-depth descriptions of some of the major organisations active in ICT standardisation.

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1 Introduction - Why do we need (ICT) standards?

'Standards are not only technical questions. They determine the technology that will implement the Information Society, and consequently the way in which industry, users, consumers and administrations will benefit from it.'

You can hardly put it more succinctly than this quote taken from a document published by the European Commission on 'Standardization and the Global Information Society'. Information and communication technologies (ICT)[1] will have a profound impact as the major enabler of the move from an industrial society to the information society to the knowledge society. Yet, this transition will only occur reasonably smoothly if adequate standards are in place that take into account not only the technical aspects, but also the characteristics of the specific environment within which they will have to function.
Even if we disregard social, moral and religious rules for the moment, standards - in a very general sense - have been with us for quite some time: about 5,000 years ago the first alphabets emerged, enabling completely new forms of communication and information storage. Some 2,500 years later, the first national, coin-based currency, invented by the Lydians, established the basis for easier inter-regional and even international trading.



Figure: A Lydian coin (© livius.org)

[1]ICT denotes both the hardware and software necessary for the operation of telecommunication systems and information technology systems.

The industrial revolution in the 18th century and, more so, the advent of the railroad in the 19th century resulted in a need for technical standards[2], which was once more reinforced when mass production generated a demand for interchangeable parts. At the same time, the invention of the electric telegraph in 1837 triggered the development of standards in the field of electrical communication technology.
In 1865 the International Telegraph Union[3] - later to become the International Telecommunication Union (ITU)[4] in 1932 - was founded by twenty states. The other major international standards setting body, the 'International Organization for Standardization' (ISO) was established in 1947. These days, a web of Standards Developing Organisations (SDOs)[5], i.e. organisations such as ISO and ITU at the global level, the 'European Telecommunications Standards Institute' (ETSI) at the supranational level, and the 'American National Standards Institute' (ANSI) and the 'British Standards Institution' (BSI) at the national level issue what are commonly referred to as 'de jure' standards[6] - although none of their standards have any regulatory power.

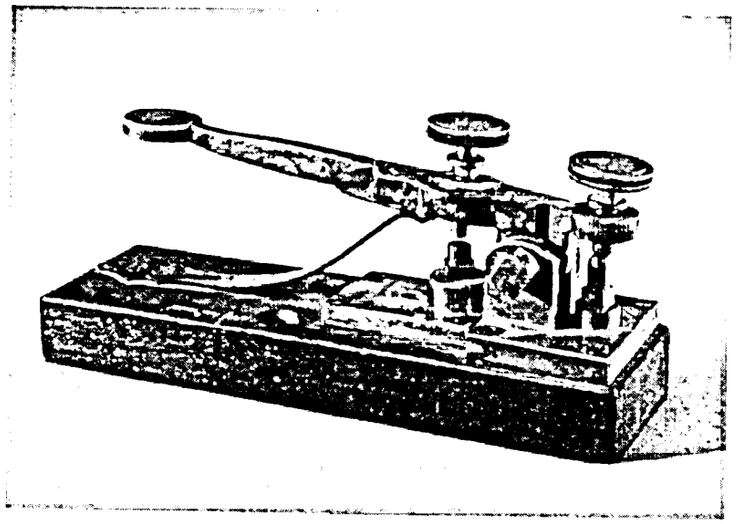


Figure: A Telegraph (© The Smithsonian)

[2]Technical standards enable compatibility between individual parts of technical artefacts, e.g. width of railway gauges, screws, etc.
[3]On 17 May 1865, the first International Convention was signed by 20 countries, and the International Telegraph Union was set up.
[4]ITU is a United Nations agency for information and communication technology issues. Among other tasks, ITU coordinates the global use of the radio spectrum, working to improve telecommunication infrastructures in the developing world, and establishing global standards (called 'Recommendations') to enable seamless interconnection of a variety of communications systems.
[5]The term 'SDO' denotes 'formal' standards bodies such as ITU and ISO.

Likewise, a plethora of industry fora and consortia (a recent survey found more than 250; [ISSS, 2008]), such as the 'World Wide Web Consortium' (W3C)[7] and the Open Group[8] - to name but a few of the longer-standing ones, produce so-called 'de facto' standards[9].

As a result, there exists an almost impenetrable maze of what are generally called 'standards', ranging from company-specific rules, through regional and national regulations, to globally accepted standards. Moreover, one may dis-tinguish between different types of standards: there are voluntary[10], regulatory[11], de jure, de facto, pro-active[12], reactive[13], industry[14], and proprietary[15] standards; this list is by no means exhaustive. As Andrew Tanenbaum put it: 'The nice thing about standards is that there are so many to choose from.'
Every ICT system, from the most complex corporate infrastructure of some globally operating company down to the humble PC on the desk at home, incorporates and observes scores of standards. There are standards for operating systems, programming languages, user interfaces, communication protocols, disk drives, cables and connectors, etc, etc. In fact, these systems do not just implement standards, they are actually shaped by them to a considerable degree. If you stop and think about it, you will realise the enormous importance of ICT standards[16] for businesses, and even for the individual. Yet, standardisation still appears to be the most underestimated and undervalued activity in the realm of ICT. Typically, it is considered a necessary evil at best, and unless a company has really strong business interests in a specific sector it can hardly be bothered to actively contribute to standards setting at all.
On the one hand, that is. On the other hand, 'standards' setting industry consortia[17] are popping up at an almost alarming rate. How come? Or, more precisely, why do companies spend considerable amounts of money on becoming a 'premium' member of a consortium, while at the same time they could not care less about related activities going on within, say, ISO? Common wisdom has it that consortia move faster, are more flexible and more business-oriented, and that they are thus destined to come up with really useful solutions very quickly. But is this true?

[6]'de jure' is a slightly misleading term, typically used to denote standards that originate from 'formal' bodies. It is misleading since use of these standards is completely voluntary.
[7]The World Wide Web Consortium (W3C) is the leading organisation for the development of Web standards. In May 2009, the W3C had nearly 400 members.
[8]The Open Group is an industry consortium to set open standards for computing infrastructure.
[9]'de facto' is a term typically used to denote standards that were developed through a private standards consortium and/or are proprietary
[10]'Voluntary standards' are those whose development is not required by law.
[11]Development of 'regulatory standards' is required by law (e.g. in the health and safety sector).
[12]Pro-active standards are developed to meet expected future demands and are developed from scratch (i.e. not based on existing technology).
[13]'Reactive' standards are basically just existing industry specifications turned into standards.
[14]An 'industry standard' was not developed through an SDO but has established itself in the market.
[15]'Proprietary standards' are owned by an organisation or a consortium.
[16]'ICT standards' are used in the ICT domain.
[17]A 'consortium' comprises a number of companies and other organisations collaboratively working towards a common goal (which may be a standard).

The desire to make sure that the 'right' standard emerges normally lies at the heart of firms' involvement in the standards setting process, be it in the 'official' process[18] or in consortium-led activities. Yet, what exactly characterises the 'right' or at least a 'good' standard is far from being clear. One author associates a good standard with the attributes of 'speed' and 'meeting technical requirements'. Whilst these characteristics are valuable for winning stakeholders' support, this is a surprisingly narrow focus. Clearly any technical specification should meet technical demands; the issue of speed, however, is popular, yet questionable. Moreover, meeting organisational and, particularly, societal requirements should clearly play a role in standards setting as well. Regrettably, though, trying to prevent standards from coming into being may also be a motivation for participation. These days, standardisation is becoming all the more important with increasing economic and corporate globalisation. At the same time, standardisation politics are changing. Strangely, national interests are becoming more important. A domestic standard successfully introduced into the global arena will not least boost the prospects of the domestic economy. Accordingly, governments now have a vested interest in pushing such standards to support domestic firms. These firms, in turn, will look to standards setting for several reasons which are typically, though not necessarily, related to their own economic well-being. Standardisation may thus to some degree be seen as an interface between technical and non-technical (e.g. economic, organisational or social) considerations. Standards are not only rooted in technical deliberations, but also result from a process of social interactions between the stakeholders.

This means you also have to think about the economic consequences of standardisation. The pros and cons of contributing to standardisation activities vs. trying to push a proprietary solution need to be considered by companies. Standards-based products or services may imply price wars and lower revenues, but may also open new markets and widen the customer base. Offering a proprietary solution may yield (or rather keep) a loyal customer base but may also result in a technological lock-in[19] and, eventually, marginalisation for the vendor or service provider. In fact, the economics of standards seems to be the best-researched aspect. There are other maybe more theoretical questions surrounding standards. Do they really hamper progress and stand in the way of technical innovation? A very popular perception, but is it accurate? Should we really leave it to the market - and its hype - alone to decide on winning technologies? Technology studies tell us that this would be unwise, but are they correct?

[18]The term 'official standards process' is used to denote a process led by SDOs: the 'formal' bodies such as ISO and ITU-T.
[19]Once an organisation has decided to install a proprietary system, it may experience major difficulties if its decision has to be revised at a later stage, and a different system is to replace the old one. The more severe these difficulties, the stronger the 'lock-in' into the old technology will be.

Now, please do not expect this chapter to answer these questions - it will not... Instead, it will go to examine on some of the aspects touched upon above. It will also briefly describe some of the most important SSBs[20] in the ICT sector.

2 ICT standardisation - A general overview

ICT standardisation is typically considered a necessary evil at best or, rather more frequently, as a complete waste of valuable resources, and as something hampering progress. Yet, a little consideration reveals that not very much would function without common standards (using this term rather loosely for the moment). This holds for the world at large - just think about language, currency, paper size, and it holds especially for the ICT domain. I do not know how many standards are implemented in a normal PC, but my guess would be somewhere in the high two-figure range. And standards are becoming even more important for communication systems. Whereas a stand-alone PC could work without standards, the telephone network and the Internet cannot.
Thus, it seems a little strange that standards, and standards setting, would have to lead such a marginal existence. It seems even stranger when you consider the costs: it has been estimated that the costs for the development of an average ICT standard amount to about $10,000,000 [Spring 95] - and that is only one standard. Another estimate says that the development cost for a 'major international telecommunications standard' may amount to some 1,000 person-years of experience, twenty person-years of actual effort, plus $3 million [OTA 92]. JTC1[21] alone has been producing between forty and fifty standards per year for the last decade.

2.1 Terminology

'Standard' and 'standardisation' are tricky terms. They are even more tricky when it comes to ICT. Think about it for a minute - what exactly establishes a 'standard'? Is a specification rubber-stamped by of one of the 'official' standards setting bodies a standard? Or is the degree of usage of a system or a product the decisive factor - is, for instance, MS-Word a 'standard', or SAP/R3? Do industry consortia actually issue 'standards'?

[20]The term 'SSB' refers to both the 'formal' bodies (e.g. ISO, ITU-T, at the global level, ETSI at the European level and BSI at the national level) and industry consortia (such as W3C and OASIS)
[21]'Joint Technical Committee 1' is the 'joint ICT arm' of ISO and IEC (International Electrotechnical Commission).

And what about the Internet - are the 'Requests for Comments' (RFCs)[22] published in the STD series[23] standards? Ask any three people and the odds are that they will come up with at least four different opinions. As does the literature. For instance, Webster's New Universal Unabridged Dictionary defines a standard as 'An authoritative principle or rule that usually implies a model or pattern for guidance, by comparison with which the quantity, excellence, correctness, etc. of other things may be determined'. The Oxford English Dictionary says a standard is 'The authorized exemplar of a unit of measure or weight; e.g. a measuring rod of unit length; a vessel of unit capacity, preserved in the custody of public officers as a permanent evidence of the legally prescribed magnitude of the unit'. These definitions already hint at a major dilemma in the theory of standardisation: there is no generally agreed-upon definition of what constitutes a standard, and the definitions that do exist cannot really be meaningfully applied to the ICT domain.

The definition adopted by ISO says that a standard is a document, 'established by consensus and approved by a recognised body, that provides, for common and repeated use, rules, guidelines or characteristics for activities or their results, aimed at the achievement of the optimum degree of order in a given context.'

This definition restricts the scope of what is colloquially referred to as a standard in two ways: firstly, it limits the sources from which a standard may emerge to a 'recognised body'[24]. Whether or not this includes specifications issued by industry fora may be a question for debate. Secondly, standards are said to be established 'by consensus'. This part excludes legislation from being seen as standards. In any case, this definition will be used throughout this chapter, with 'recognised body' assumed to include standards consortia as well.

2.2 The ICT standardisation universe

Over the last three decades, the world of ICT standardisation has changed dramatically, from the fairly simple, straightforward and static situation that could be found in the seventies. Back in the seventies, there was a clear distinction between the then 'monopolist' CCITT[25] on the one hand, and the remainder of the world of ICT standards on the other. CCITT was in charge of standards setting in the telecommunications sector. It was basically run by the national PTTs[26], which still enjoyed a monopolistic situation in their respective countries. ISO was in charge of almost all other ICT-related standardisation activities. The various national SDOs developed their own specific standards but also contributed to the work of ISO in Europe. Over time, two trends have contributed to an increasingly complex ICT standardisation environment: the growing importance of ICT, the globalisation of markets. In a way, these have been coupled, and further accelerated, by the Internet, which was 'discovered' for commercial use in the mid-nineties.

The web of SSBs in the 1970s

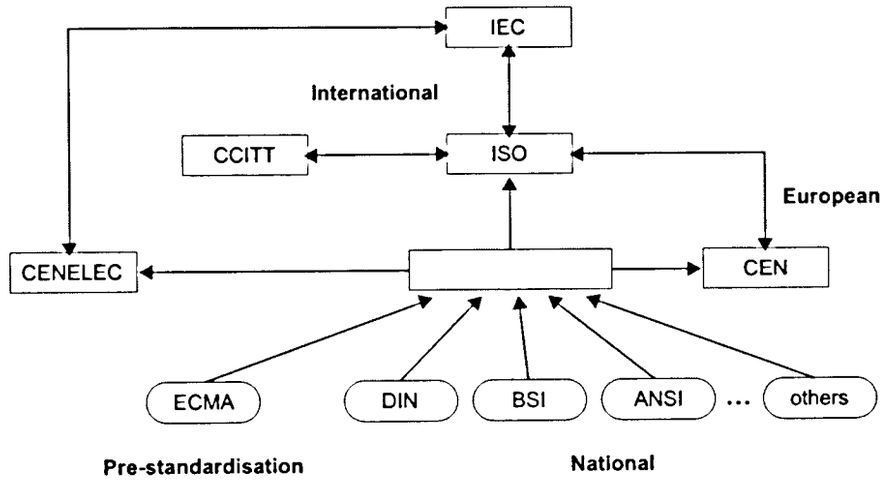


Figure: The web of SSBs in the 1970s (© Jakobs)

Further complexity was caused by the liberalisation of the telecommunications market and the associated emergence of supranational standards bodies, such as ETSI in Europe, TIA[27] in the United States and TTC[28] in Asia. This was reinforced by the still ongoing merger of the formerly distinct sectors of telecommunications and ICT, which caused considerable changes in these markets [David, 1995].

[22] 'Request for Comments'. This is a series of documents describing a broad variety of respects of relevance to the Internet. They are typically produced by the IEFT (Internet Engineering Task Force), the Internet's standards setting body.
[23] The documents of the STD series are the actual standards that pretty much govern the Internet and describe its functionality. All STD documents are RFCs, but not vice versa.
[24] Such a 'recognised body' is an SDO. They are recognised by some legal authority; for example, ITU is a UN agency, and the European standards organisations are recognised by the EU.
[25] CCITT is the International Telegraph and Telephone Consultative Committee, the predecessor of the ITU-T.
[26] PTT= Post, Telegraph and Telephony. Prior to the liberalisation of the telecommunication market, each country had typically one state-owned PTT that had the monopoly on telecommunication services in that country.
[27] Telecommunication Industry Association.
[28] Telecommunication Technology Committee.

These processes primarily affected SDOs and the relations between them. In addition, and as 'external' competitors, standards consortia emerged as a new phenomenon. Well-known examples today include the W3C[29], OASIS[30], or the OMG[31].
Also, the economic importance of standards grew. A technology 'ennobled' by having become a standard held the promise of huge financial gains for its proponents. Likewise, backing a losing system would imply both severe monetary losses and a severely reduced market share for its supporters.

Web of SSBs active in the ICT sector (excerpt)

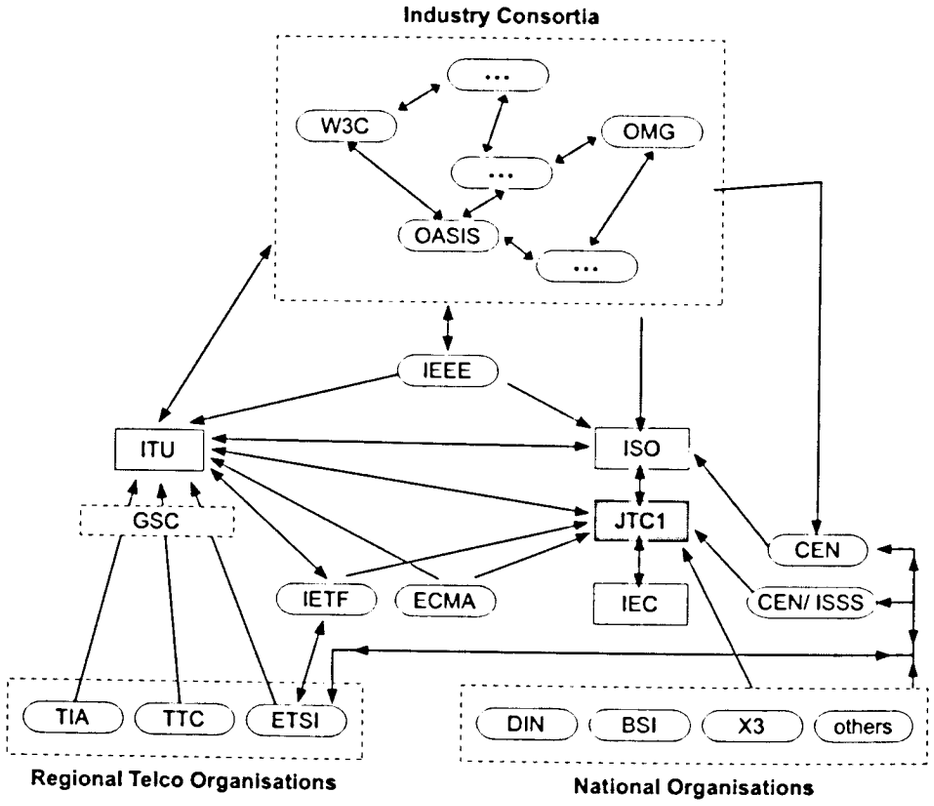


Figure : Web of SSBs active in the ICT sector (excerpt) (© Jakobs)

[29]The World Wide Web Consortium.
[30]The Organisation for the Advancement of Structured Information Standards.
[31]The Object Management Group.

In an attempt to save the day, new consortia could be established to standardise the losing system. Obviously, this approach increased the number of consortia and led to an even higher complexity of the standards setting environment.
As a result, for a number of years consortia emerged at an amazing rate [Cargill, 1995]. This was largely in response to the enormous speed of technical development in ICT and e-business systems. 'Traditional' SDOs were widely considered as not being capable of coping with this speed (see e.g. [Besen, 1995], [Cargill, 1995]; see also the chapter on ICT standards consortia)). Today, more than 250 ICT standards consortia have been identified in [ISSS, 2008].

To further increase complexity, a proliferation of sector-specific standards may be observed in Europe, especially in the e-business domain. The most prominent representatives here include CEN/ISSS Workshop Agreements (CWAs)[32], many of which have been tailored towards the needs of a dedicated industry sector. One effect, which was a direct result of the trends outlined above, is that many companies, especially large manufacturers, vendors, and service providers, are forced to participate in a much higher number of SSBs than they used to, in order to make sure that they do not miss a potentially relevant development (see e.g. [Updegrove, 2003]).
The Internet's standards body, the IETF[33], should also be mentioned. This body plays a rather special role thanks to the unprecedented importance of the Internet in today's economy. For many years the IETF had not been accepted as a standards setting body, and its output, the Internet Standards, were not recognised by government procurement regulations [Werle, 2002].
This has changed now, though. Also, the IETF may be regarded as the role model for many large consortia, such as the W3C and OASIS, which have based their processes on that of the IETF. In fact, many have considered the IETF's process as superior to those of the formal SDOs (see e.g. [Crocker, 1993], [Monteiro, 1995], [Solomon & Rutkowski, 1992]).

2.3 Discussing the situation

The complex environment outlined above represents a major obstacle for those who are considering active participation in standardisation, as well as for those who are looking for a standard that best suits their needs. Considering this complexity of the ICT standardisation universe, 'Where to participate?' is a relevant question. Functionally equivalent systems may well be standardised in parallel by different SDOs and consortia, and participation in all relevant work groups is well beyond the means of all but the biggest players. The correct decision here is crucial, as backing the wrong horse may leave a

[32]CWAs are not CEN standards. They only require consensus between the workshop participants.
[33]Internet Engineering Task Force.

company stranded with systems based on the 'wrong' (i.e., non-standard) technology. In addition to the more practical aspects that need to be considered when selecting the best suited SSB for particular standards setting activity, other, less tangible, aspects may play a role in such decision processes, too. In particular, this may include the perceived reputation of an SSB.

Perceptions of the importance and relevance of different types of SSBs differ widely. For instance, Rutkowski offered a rather extreme point of view - *'The Internet standards development process is by far the best in the business.'* [Rutkowski, 1995]. However, things have changed since the times when the IETF, on the one hand, and ISO and CCITT, on the other, were basically the only players in the international ICT arena. These days, the IETF is one of a number of accepted members of the global web of standards setting bodies. Likewise, the role of the national SDOs has changed. This holds particularly for Europe, where 90% of standards produced are European or international (as opposed to national; this ratio has changed dramatically within a couple of years) [Bilalis & Herbert, 2001]. Along similar lines, Ghiladi fears that *' ...non-harmonized national standards and rules have the effect of erecting barriers.'* [Ghiladi, 2003].
Moreover, in an attempt to improve their position in the competition with consortia many SSBs have introduced 'new deliverables'. These are documents which have not gone through the full-blown process that leads towards a 'standard', but are more akin to the specifications issued by consortia (i.e. they require only a lower level of consensus, and can be published more quickly). Obviously, this move has introduced further complexity into standardisation.

Many consortia and other SSBs outside the network of formal SDOs have established themselves as recognised sources of standards. Initially, though, their output was considered 'inferior' to that of the formal bodies, which had major repercussions, e.g. in (public) procurement (see e.g. [Heafner, 1988], [Werle, 2002]). Here, Europe's commitment to OSI in the 1980-90s was a remarkable example. In addition to their undoubted technical superiority, one of the major reasons why OSI standards were considered preferable to their Internet counterparts was the fact that ISO, where the OSI standards were developed, was a formal SDO, unlike the IETF, which was viewed with considerable suspicion. Similar views could be observed in the private sector.
A standards inventory project in the US petrochemical industry, for instance, established rules where *' ...preference was given first to international standards, followed by national standards, and then consortium specifications.'* [Kowalski & Karcher, 1994].
Yet, by now Europe has recognised that: *' ...consortia and fora are playing an increasing role in the development of standards, ... the European Standards Organisations have to recognise these facts and re-design policies, processes and organisational structures, in close collaboration with stakeholders and in particular industry ...'* [EC, 2004b], albeit with some concern: *'It is considered*

doubtful whether, in the light of the speed of development and the limited participation of experts, the fundamental principles for accountability of standardisation such as openness, consensus and transparency are followed in a robust fashion.' ([EC, 2004a]; see section 4 for a sketch of the industry's view on this). Interestingly, this position has been challenged in [Egyedi, 2003], stating that democracy should not necessarily be required from consortia processes.

2.4 Coordination in ICT standards setting

Standardisation is basically a mechanism for coordination [Werle, 2001]. Not unlike the research sector, standards setting serves as a platform for co-operation between companies which are otherwise competitors. According to [Werle, 2001], a company has different options concerning standards setting:
- To try and bypass organised standardisation and set a 'de facto' standard.
- To participate in the work of an SDO or a private standards consortium.
- To set up a new consortium or forum which deals with the standards project.

If it is assumed that standards setting work will eventually commence, the interests of the various stakeholders are likely to differ. In other words, each participating organisation may try to either push its own ideas, propose a 'neutral' solution, or just try to impede the whole process in order to prevent any standard in the field in question. According to [Besen, 1995] four distinct situations are possible:
- Common interests
  There are no competing proposals, and a decision can quickly be reached by consensus. All parties involved attempt to serve the common good.
- Opposed interests
  Each opponent prefers his own proposal to be adopted, but would prefer no standard at all to the adoption of a competitor's proposal. This situation arises when the gains associated with the winning proposal are comparably big compared with the gains for the industry as a whole.
- Overlapping interests
  Again, each opponent prefers his own proposal to be adopted, but would rather have a competitor's proposal adopted than have no standard at all. This may happen if, contrary to the situation outlined above, the whole industry stands to benefit the most from the adoption of a standard (regardless of where it originated from) rather than the original proposer.

- Destructive interest
  At least one player prefers not to have any openly available standard at all, and accordingly tries to slow down the process. This player typically is a

major vendor largely dominating the market with a proprietary product who would lose market shares if a standard were in place.

Obviously, the above alternatives all come down to the question of competition vs. cooperation. The path towards competition may eventually lead to a company's dominating market position with a product or service based on their own proprietary specification. Yet, at the same time the virtual absence of other players may render this particular market insignificant. On the other hand, cooperation establishes a broader market for products or services based on open specifications, created through, and capable of accommodating, a number of different players. As has for instance been shown in [Swann, 1990], a product that succeeds in creating an environment in which other vendors consider it beneficial to produce compatible products will prove considerably more successful than its competitors. Such compatible products can only emerge if the underlying original specifications have been made public, or if a very liberal licensing policy has been pursued. This example serves to highlight potential benefits to be gained from open specifications, even if the product itself is inferior to its (less open) rivals in terms of the functionality provided. Here, the range of products compatible to the original specification strengthen its status as a de facto 'standard', which in turn triggers the development of even more compliant products [Swann, 1990]. As a result, a bigger market has been established, leading to increased revenues.

2.4.1 Current status

Today, various forms of cooperation between SSBs may be found. In the realm of SDOs, 'horizontal' cooperation between the international SDOs (ITU, ISO, IEC[34]) is regulated by a dedicated guide for cooperation between ITU-T and JTC1. This document specified different forms of cooperation, but also makes it very plain that *'By far, the vast majority of the work program of the ITU-T and the work program of JTC 1 is carried out separately with little, if any, need for cooperation between the organizations'*. Similarly, the CEN/CENELEC[35]/ ETSI 'Joint Presidents' Group (JPG) coordinates the standardisation policies of the European Standards Organisations (ESOs)[36] in accordance with a basic cooperation agreement. Moreover, Directive 98/34/EC mandates that conflicting standards have to be withdrawn. This is managed 'horizontally' by the ESOs, and 'vertically' by their members, the National Standards Organisations (NSOs). 'Vertical' cooperation between ESOs and the international bodies is governed by individual documents. Here, the major need for cooperation and coordination is primarily sector-specific (ICT, Telecom).

[34]The International Electrotechnical Commission.
[35]The European Committee for Electrotechnical Standardisation.
[36]The ESOs are CEN, CENELEC and ETSI.

Cooperation between international and regional SDOs in the ICT sector

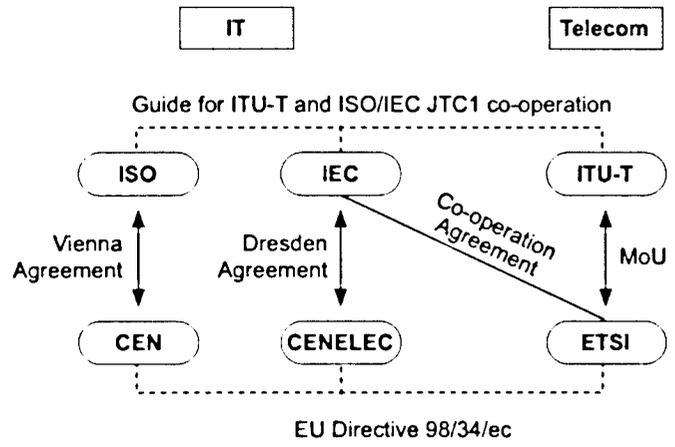


Figure: Cooperation between international and regional SDOs in the ICT sector (© Jakobs)

The 'Vienna Agreement'[37] provides the rules for cooperation between CEN and ISO; analogously, the 'Dresden Agreement'[38] governs relations between IEC and CENELEC. Somewhat surprisingly, only a rather more informal Memorandum of Understanding (MoU) exists for the cooperation between ETSI and ITU. On the other hand, and also rather unexpectedly, a dedicated agreement guides the relations between ETSI and IEC[39].

In general, the 'vertical' agreements and MoUs define various levels of cooperation and coordination, albeit in comparably vague terms. Nonetheless, cooperation between CEN and ISO, and CENELEC and IEC has been very successful in many cases, primarily through joint working groups. In contrast, the documents governing the respective 'horizontal' cooperation are far more rigorous. This holds particularly for the European Directive that regulates the relations between the three ESOs.

The Global Standards Collaboration (GSC) covers both vertical (between regional telecommunication standards bodies and the ITU) and horizontal coordination (between regional telecommunication standards bodies). It provides for the regular exchange of work programmes and other information between its members. However, it is likely that the progressing merger of the ICT and telecommunications sectors will pose additional problems in this respect, such as the

[37]http://www.wipo.int/treaties/en/classification/vienna/trtdocs_wo031.html.
[38]http://www.iec.ch/about/partners/agreements/cenelec-e.htm.
[39]http://www.iec.ch/about/partners/agreements/etsi-e.htm.

need to include new members (from the ICT sector). (*http://www.gsc.etsi.org/Presentation.htm*)
ETSI Partnership Projects[40] represent a different albeit related approach to co-ordination. Covering both SDOs and consortia, such projects co-ordinate a group of regional SDOs and industry consortia working towards a common objective. The '3rd Generation Partnership Project' is the most prominent example. In the e-business sector, a specific MoU exists between ISO, IEC (the 'parent' organisations of JTC1), ITU, and UN/ECE[41] [MoU, 2000]. In addition, a number of organisations have been recognised as participating

ETSI Partnership Projects

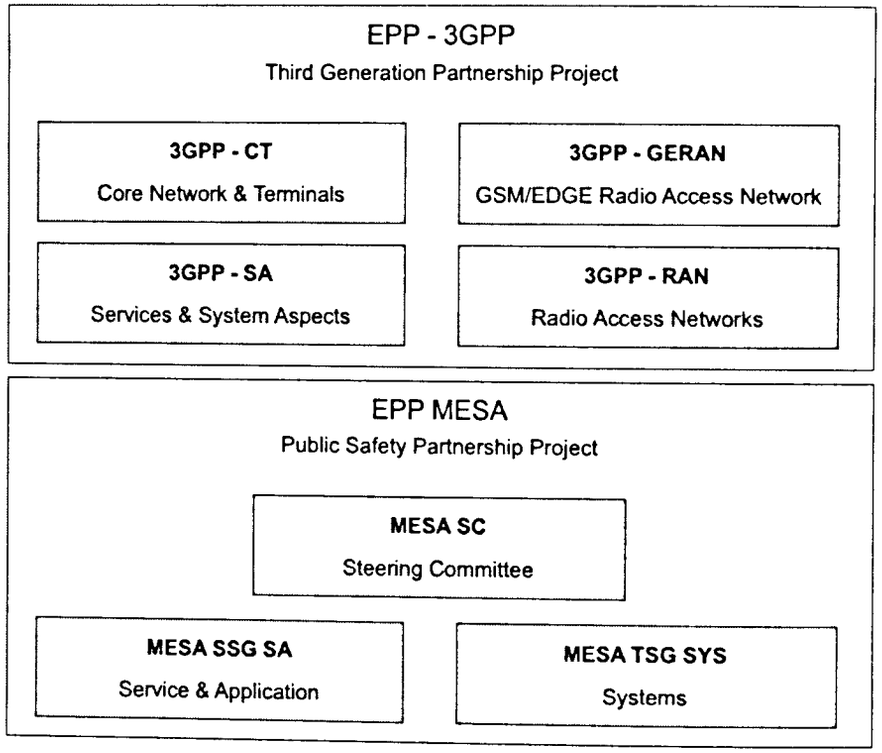


Figure: ETSI Partnership Projects (© ETSI)

[40] 'Where appropriate, ETSI will base its activities on Partnership Projects committed to basic principles such as openness, clear Intellectual Property Rights (IPR) policy and financial co-responsibility, to be established with partners of any kind (global or regional, Standards Development Organisations (SDOs) and Fora, etc.).' http://www.etsi.org/etsi_galaxy/worldwide/partnership/partnership_a.htm
[41] The United Nations Economic Commission for Europe

international user groups. The MoU aims to minimise the risk of conflicting approaches to standardisation, to avoid duplication of efforts, to provide a clear roadmap for users and to ensure inter-sectoral coherence. Most notably, its 'division of responsibilities' identifies a number of key tasks and assigns one of the four signatories to each of them.
Overall, the co-ordination of the work of the SDOs appears to be reasonably well organised[42]. This does not necessarily hold for the coordination between SDOs and consortia. Numerous cooperation arrangements do exist, however, the current situation can be best described as piecemeal; there is no over-arching framework to organise the individual cooperation arrangements.
An initiative taken by the three ESOs is a promising development. The ICT Standards Board (ICTSB) aims to coordinate specification activities in the field of ICT. In addition to the ESOs, the ICTSB membership comprises major standards consortia. It's objectives include[43]:

- The analysis and co-ordination of requirements on standardisation.
- The translation of these requirements into standardisation programmes or projects.
- The allocation of work to the most appropriate specifying body (SDO or consortium).

Another relevant coordination mechanism is that of 'Publicly Available Specifications' (PAS). The directives of the 'ISO/IEC Joint Technical Committee 1' (JTC1), which pioneered the PAS procedure, states that ' *...constitutional characteristics of the [PAS-submitting] organisation are supposed to reflect the openness of the organisation and the PAS development process'*. [JTC1, 2004]. The PAS procedure is a means for JTC1 to transpose a specification more rapidly into an international standard. The specification starts out as a Draft International Standard (DIS), which, if approved by JTC1 members, immediately acquires the status of an International Standard (IS) [Egyedi, 2000]. This mechanism has primarily been designed to enable JTC1 to transpose specifications that originated from consortia into international standards. In this capacity it also serves as a mechanism to at least contribute to coordination of work performed within consortia and the world of formal SDOs. With respect to the coordination between individual consortia the situation is even worse. Here as well cooperation tends to occur more at the level of technical bodies (if at all) than at SSB level. In most cases, however, the world of standards consortia experiences more competition than cooperation. There is direct competition between consortia covering similar ground, for instance, between RosettaNet[44] and ebXML[45].

[42] There have been exceptions, though, which need to be avoided in the future. For example, the IEEE 802.11a/b/g activities and ETSI's HIPERLAN/2 covered the same ground and were in direct competition (ETSI 'lost').
[43] http://www.ictsb.org/archives/archives_inform ation_highway.htm.
[44] RosettaNet is a private consortium that aims at the defining standard process in the electronic business domain
[45] Electronic Business eXtended Markup Language. This is a set of XML based standards sponsored by OASIS aiming to provide an open infrastructure to enable the global use of electronic business informations.

Members of the ICTSB

Fora & Consortia
- European Broadcasting Union (EBU)
- Standardizing Information and Communication Systems (Ecma International)
- European Industry Association (EICTA)
- Liberty Alliance Project
- Organization for the Advancement of Structured Information Standards (OASIS)
- Open Mobile Alliance (OMA)
- RosettaNet (Consortium of major Information Technology, Electronic Components, Semiconductor Manufacturing, Telecommunications and Logistics companies)
- The Open Group
- Internet Society (ISOC-ECC)
- World Wide Web Consortium (W3C)

European Standards Organisations
- European Committee for Standardisation (CEN)
- European Committee for Electrotechnical Standardisation (CENELEC)
- European Telecommunications Standards Institute (ETSI)

Observers
- European Commission
- EFTA Secretariat
- European Association for the Co-ordination of Consumer Representation in Standardization (ANEC)
- The European Office of Crafts, Trades and SMEs for Standardisation (Normapme)

Figure: ICTSB members (© ICTSB)

2.4.2 Competition in standardisation

The easiest way to achieve coordination would be what van Wegberg calls the 'Grand Coalition' [van Wegberg, 1999]. This represents the most centralised solution supported by all stakeholders. The level of coordination would assure that a single standard would be established. In other words, technologies in use would be fully compatible and positive network externalities could be realised [van Wegberg, 1999]. In practical terms, this would imply that all standardisation work on a given topic would be carried out by one working group. In practice, however, the process is fragmented in many cases. This may be due to several reasons. For one, different stakeholders may consider different SSBs as optimal for their specific individual needs. Likewise, a new SSB may be established by stakeholders (or one individual stakeholder) who are dissatisfied with the work of an SSB, and feel they would be better off with a consortium of their own to promote their ideas and technologies.

However, the fragmentation of the standards setting world does not necessarily lead to competition. Fragmentation, may, for instance, occur according to the geographical scope of an SSB, the industry sector within which it is active, and its 'formal status' (accredited SDO or consortium) [Werle, 2001]. Whereas all these distinctions lead to blurring, the former two do not necessarily lead to competition or conflicts.
In 2001, Werle observed that *'Conflicts between standards organizations* [as opposed to conflicts within one SSB] *over their claims of competence or their involvement in overlapping areas of standardization have been rare'* [Werle, 2001]. Today, this does not necessarily hold any more. And most conflicts arise between an SDO and a consortium, or between consortia. Some well-known examples of conflicts between SSBs include:
- Wireless Home Networks
  802.11 (IEEE) / Bluetooth (Bluetooth Special Interest Group) / HomeRF (HomeRF™ Working Group).
- Wireless LANs
  HIPERLAN/2 (ETSI) vs 802.11 (IEEE).
- Cellular Trunked Radio Systems
  Tetra (ETSI) - Tetrapol (Tetrapol Forum).

2.4.3 Improving the situation

To develop ' *...procedures by which the needs of consortia can be better accommodated in ESOs. ESOs should fully exploit the potential for synergies by improving their cooperation and reinforce their mechanisms of coordination for subjects of common interest'* [EC, 2004b], several routes could (and should) be followed.
- Strengthen existing coordination activities.
  Initiatives such as the MoU on e-business standardisation and the ICTSB should be encouraged to involve more SSBs and other relevant organisations. Also, for standardisation in the e-business sector, it would be helpful if the ICTSB established a dedicated Working Group for e-business, to coordinate the relevant activities of its members.
- Develop new forms of cooperation between SDOs and consortia.
  In the light of increasingly similar membership, processes, and 'Intellectual Property Rights' (IPR) regimes[46] of major consortia and SDOs it would make sense to extend to major consortia those forms of co-ordination and cooperation already in place between SDOs. Such a situation may take the form, for example, of a mutual exchange of documents and work programmes, exchange of observers, the right to submit input, and joint working groups.

[46]Intellectual Property Rights. Standards may incorporate technology that has formerly been parted. The patent holder is requested to either waive any royalties he might receive from implementers of the standard ('Royalty Free (RF) licensing' or agree to license the technology on 'Free, Reasonable and Non-Discriminatory' terms (FRAND). The latter has been the more popular solution so far.

Also, the PAS[47] procedure offers useful mechanisms to improve cooperation between SDOs and consortia. Coupled with a suitable division of labour (see below) better exploitation of these mechanisms could save considerable time and effort. This would, however, require pro-active 'marketing' of these mechanisms to consortia (after all, they will need to benefit from them as well).

- Identify a suitable division of labour between SDOs and consortia.
  A division of labour between 'infrastructure' and 'applications' would be beneficial. Given the diverse characteristics of infrastructure technologies and applications, on the one hand, and of SDOs and consortia, on the other, the former should focus on standards for a long-lived infrastructure, while the latter should concentrate on standards for the more dynamic sectors, e.g. on e-business applications.

2.5 The issue of 'open standards'

The term 'open standard', albeit widely used, has not really been clearly defined. It therefore holds competing connotations for different actors. Its basic idea draws much on the implicit opposition to the situation of a pure market standard. An open standard means that the actors involved deliberately set out to codify the standard as non-proprietary knowledge, to ensure that in effect no individual commercial interests control the resulting products and to guarantee that in fact the open standard is made accessible and usable to all interested parties on reasonable and equal terms, even where proprietary technologies are implied.

These general aspects of an open standard do, however, invite interpretation, for example, on what constitutes 'equal terms'. The recent attempt by the IDABC 'European Interoperability Framework' [IDABC, 2004] at a formalised definition illustrates the type of difficulties that such interpretations lead to. According to this document, ' *...the following are the minimal characteristics that a specification and its attendant documents must have in order to be considered an open standard:*

- *The standard is adopted and will be maintained by a not-for-profit organisation, and its ongoing development occurs on the basis of an open decision-making procedure available to all interested parties (consensus or majority decision, etc.).*
- *The standard has been published and the standard specification document is available either free or at a nominal charge. It must be permissible for all to copy, distribute and use it for no fee or for a nominal fee.*

[47]The PAS procedures are used to transpose proprietary specifications into standards. Typically, an organisation that wishes to submit a PAS has to meet certain criteria, and agree to follow strict rules during specification development.

- *The intellectual property - i.e. patents possibly present - of (parts of) the standard is made irrevocably available on a royalty-free basis.'*

Unfortunately, all three elements of this definition may potentially cause problems. The requirement for a standard's maintenance is the least critical of them. Nonetheless, many SSBs do not have a formal systematic review mechanism in place to ensure that a standard is maintained[48]. In many of these cases, however, a standard can be adapted to new requirements or changing environmental conditions by having a new version go through the same approval procedure that any other new standard would have to go through.

Also, few standards are actually available for free (e.g. neither CEN/CENELEC nor ISO/IEC standards are, with very few exceptions; however, those from ETSI are). It is unclear whether or not the fees charged by ISO are 'nominal' and whether they represent a barrier for the diffusion of the standards. Moreover, the requirement to be allowed to copy a standard *'for no fee or at a nominal fee'* is clearly at odds with, for instance, ISO's document licensing policy. This suggests that the enforcement of the IDABC definition would need to go hand in hand with accompanying measures to compensate SDOs for the resulting loss of a significant share of their income[49].

In particular, however, the discussion about this definition evolved around the requirement of 'Intellectual Property Rights' (IPR) to be made available on a 'royalty-free' basis. In practice, this excludes the products of the vast majority of both formal SDOs and industry consortia from the list of producers of open standards. With very few exceptions (the W3C being a very prominent one), SSBs typically ask for any IPR to be included in a standard to be made available on a 'Fair, Reasonable and Non-Discriminatory' (FRAND) basis. A recent study [Blind et al., 2002] revealed that it remains rather unclear even for those running SDOs as to how this rule is actually implemented. As a general rule, it is reported that the license should not be higher than 1% of the final product price. The latter requirement is also likely to deter IPR holders from participating in standards setting. Even applying FRAND leads to this 'adverse' selection process [Blind & Thumm, 2004a]. IPR holders may well consider it more worthwhile to follow other avenues in order to reap the benefits from their IPR.

Very much in line with the above, the Global Standards Collaboration (GSC)[50], in a recent resolution, resolves that the participating organisations *'...strongly support definitions of 'open standards' that reflect the following characteristics: such standards are (i) made available to the general public, (II) developed (or approved) and maintained via a collaborative and consensus driven process,*

[48]ISO, for example, has a well-defined maintenance process which requires ISs to be subject to a systematic review every five years

[49]This would at least hold for standards published by one of the three European bodies, CEN, CENELEC and ETSI.

[50]This would at least hold for standards published by the ITU, ETSI, the United States' Committee T1 or the Japanese TTC, with a number of other regional standards institutons as additional members. It *'...provides for the regular exchange of work programmes and other information in a number of agreed high-interest technical areas,...'.* (www.gsc.etsi.org/Presentation/home.htm)

and (III) subject to a RAND/FRAND intellectual property rights policy (for the reasons articulated above);' and *'strongly voice their opposition to policies that mandate compensation-free licensing provisions and licensing practices that discriminate between members and non-members; ...'* The IDABC definition also includes a barely comprehensible limitation, in that it limits intellectual property solely to patents. This raises the question as to why other forms of IPR (e.g., copyrights) are not covered by this definition, although they are relevant for the software which is the basis for numerous e-business and e-government standards. Furthermore, trademarks play an important role, e.g. for e-catalogues, such as BMEcat or eClass.

In general, the recent initiative to define open standards as royalty-free should analyse in-depth the consequences and discussions after the unsuccessful attempt of ETSI to change its licensing scheme to allow for compulsory licensing [Iversen, 1999]. While consumers and users may benefit in the short run, the incentives to invest in R&D would dry up in the long run. The United States even complained that such a rule would lead to the expropriation of its knowledge assets. The absence of a requirement for due process from the definition is also surprising. It is one of the cornerstones of all SDOs' processes, and also included in the processes adopted by many consortia. Due process is more than just *' ...an open decision-making procedure available to all interested parties...'*, in that it also includes the existence of an appeal authority.
Even if the IDABC definition were to be used only as a 'reference definition' against which the 'openness' of a specific standard could be measured, it would need to be revised (to address different types of IPR, and to include due process).
In the light of the IDABC definition's shortcomings discussed above the 'Consumer Project on Technology's' (CPT) definition of an 'open standard' [CPT, 2005] could be a good starting point for further deliberations. According to this definition, an open standard must

'I. be published without restriction (e.g., potential implementers are not restricted from accessing the standard) in electronic or tangible form, and in sufficient detail to enable a complete understanding of the standard's scope and purpose;

II. be publicly available without cost or for a reasonable non-discriminatory fee for adoption and implementation by any interested party;

III. Any patent or data rights necessary to implement the standards are made available by those developing the specification to all implementers on reasonable and non-discriminatory (RAND) terms (either with or without payment of a reasonable royalty or fee); and

IV. The process to develop, maintain, approve, or ratify the standard is by consensus, in a market-driven standards setting organisation that is open to all interested and qualified participants.'

One element of this definition is striking. The need for *'... sufficient detail to enable a complete understanding of the standard's scope and purpose;'* becomes understandable given this definition's source, but remains problematic nonetheless. Many, if not most ICT standards are highly complex; even in simpler cases understanding them requires in-depth technical knowledge. Moreover, natural language is not a very good means of conveying such complex technical details. This holds all the more as implicit beliefs and tacit knowledge of the standard's creators and editors have - inevitably - also been incorporated into the document.
The ICT Standard Board's[51] definition could be another good starting point for discussion. According to them, *'An open standard... should be:*

- *developed and/or affirmed in a transparent process open to all relevant players, including industry, consumers and regulatory authorities...;*
- *either free of IPR concerns, or licensable on a (fair), reasonable and non-discriminatory ((F)RAND) basis;*
- *driven by stakeholders, and user requirements must be fully reflected;*
- *publicly available (but not necessarily free-of-charge);*
- *maintained'.*

This definition avoids most of the issues discussed above, and also adds some requirements which refer to valuable characteristics of a standards setting process. It avoids the problems associated with the need for a standard to be available, and reproducible, for free. It is also more generic in its coverage of IPR. Most prominently, it does not require royalty-free licensing of patent-related IPR.
An interesting element, which is also absent from the IDABC definition, is the need to fully reflect user requirements. While this may be hard to enforce in practice (see e.g. [Jakobs et al, 1998], incorporation of (reasonable) user requirements is certainly a crucial characteristic of an open standard.
A very similar definition (excluding the need to reflect user requirements) has been published by the GSC. It defines an 'open standard' as including the following fundamental elements:

- the standard is developed and/or approved, and maintained by a collaborative consensus-based process;
- such a process is transparent;
- materially affected and interested parties are not excluded from such process;
- the standard is subject to RAND/FRAND Intellectual Property Right (IPR) policies which do not mandate, but may permit, at the option of the IPR holder, licensing essential intellectual property without compensation; and
- the standard is published and made available to the general public under reasonable terms (including for a reasonable fee or for free). *(http://portal.etsi.org/docbox/Workshop/GSC13/GSC13_IPR/GSC13-IPR-03 GSC-12 FINAL RESOLUTIONS.doc)*

[51] The ICTBS is *'an initiative from the three recognised European standards organisations and specific providers to coordinate specification activities in the field of Information and Communications Technologies.'*

3 Who does what in ICT standardisation?

3.1 Introduction

Today, a broad variety of different organisations are active in standards setting in the information and communication technologies (ICT) domain. In addition to the 'traditional' accredited standards developing organisations (SDOs), these primarily include standards consortia like the World Wide Web Consortium (W3C), and industry fora such as the Wireless World Research Forum (WWRF)[52]. Yet, even within each of these categories, organisations differ widely in terms of aspects such as overall goals, sectors of activity, membership, business models, and liaisons. Additional differences may be observed in the respective standards setting processes, with regard to, for instance, the required level of consensus, the observation of due process, and the equality of their members. Moreover, membership is for free in some, while others charge fees. Also, individual members of the working groups or committees may (have to) act in different capacities, e.g. as national or corporate representatives, or as individual experts. This section is intended to provide a brief overview of some of the more important standards setting bodies in the ICT sector. The individual descriptions cover their processes, membership structure, activity areas, etc. Relevant links are provided for those who would like to have more information.

3.2 ITU - International Telecommunication Union

The International Telegraph Union, the predecessor of the ITU, was set up as a treaty organisation in 1865 by twenty European countries. At the same time, the first International Telegraph Convention was signed. Following the invention of the telephone in 1876, the Telegraph Union began to cover international legislation in this area as well. The invention of wireless telegraphy in 1896 triggered the initiation of the first International Radiotelegraph Conference, held in 1906. This was the first Plenipotentiary Conference[53], through which the work of the Union - and later of ITU - has since been directed. The International Telephone Consultative Committee (CCIF) was set up in 1924, followed by the establishment of the International Telegraph Consultative Committee (CCIT) in 1925, and in 1927 the International Radio Consultative Committee (CCIR) was founded. In 1934, the Union's name was changed into 'International Telecommunication Union' (ITU), which became a specialised agency of the United Nations in 1947.

The International Telephone and Telegraph Consultative Committee (CCITT[54]) was founded in 1956, through the merger of the CCIT and the CCIF. In May 2009, the ITU comprised 191 Member States, 571 members (scientific and industrial companies, public and private operators, broadcasters, regional/international organisations), and 152 associates.

However, the right to vote is restricted to one representative per Member State. Other organisations, notably those referred to as Scientific or Industrial Organisations (SIOs), need to be approved by their respective governments, and only have a right to participate and to contribute to the technical work, but are not allowed to vote.

As another result of the increasingly competitive standardisation environment, the goals identified in the ITU strategy document include adoption of a market-oriented approach to standardisation, among other means through the delivery of high-quality products (i.e. their 'Recommendations') on time, and enhancement of participation and involvement by non-administration entities and organisations. Recently, efforts aimed at increased participation by academia have been launched. Further information is available at *http://www.itu.int/*. Today, separate entities within the ITU cover the three sectors 'Radiocommunication' (ITU-R), 'Development' (ITU-D), and 'Standardisation' (ITU-T).

Entities of the ITU

ITU-R manages the radio-frequency spectrum and satellite orbits. To this end, they aim to ensure interference-free operations of radiocommunication systems. This is done through implementation of Radio Regulations and Regional Agreements.
Futhermore, ITU-R develops 'Recommendations' intended to assure the necessary performance and quality in operating radiocommunication systems.

ITU-D aims to achive everyone's right to communicate, through access to communication infrastructure and information and communication services. It assists (developing) countries in the field of ICT, promotes – and participates in – actions that contribute towards narrowing the digital divide.

ITU-T develops 'Recommendations' (i.e. 'Standards') that define elements of the ICT infrastructure. Today's work extends well beyond the traditional area of telephony to encompass a far wider range of ICT.

Figure: Entities of the ITU (© ITU)

[52]The WWRF was founded in 2001. It develops directions for strategic future research in wireless communications, and contributes to work done within numerous standardisation bodies.
[53]Plenipotentiary Conferences are the top policy-making body of the ITU. They are held every four years. Their tasks include setting the ITU's general policies, and adopting four-year strategic and financial plans.

[54]CCITT is the predecessor of ITU-T

ITU structure

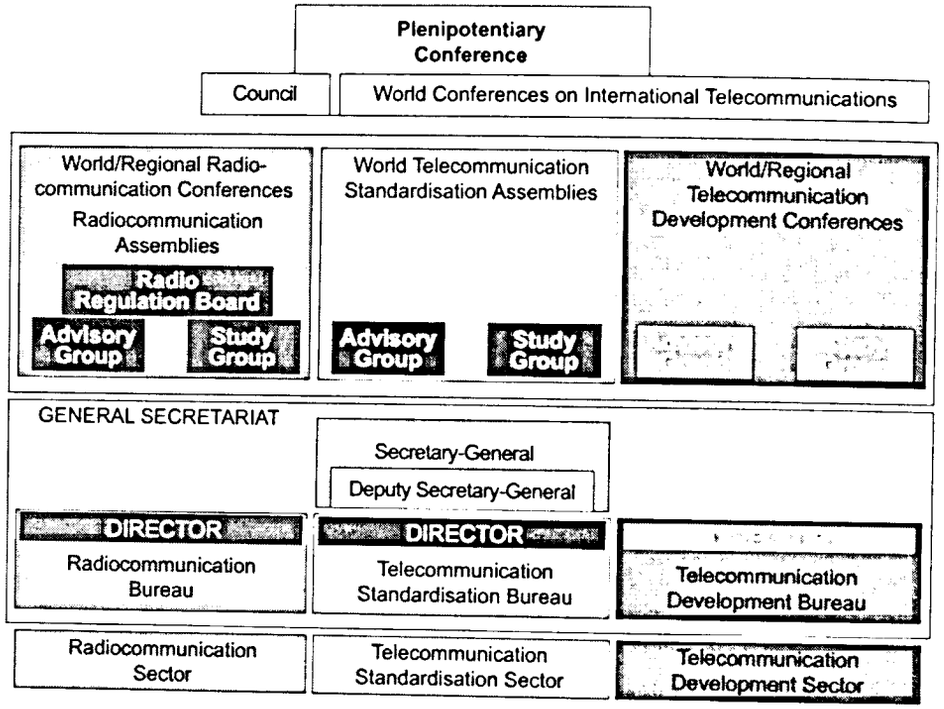


Figure: The overall structure of the ITU (© ITU)

ITU's technical and organisational work on standardisation is performed within ITU-T (the successor to the CCITT). The main products of ITU-T are normative 'Recommendations' (i.e. standards).

The quadrennial 'World Telecommunication Standardization Assembly' (WTSA[55])is the top-level decision making organisational institution. Among other activities, it defines the general policy for the sector, establishes the Study Groups, and approves their expected work programme for the next four-year period. The 'Telecommunication Standardization Advisory Group' (TSAG) provides ITU-T with flexibility between WTSAs by taking over part of the WTSA's tasks in between two Assemblies. The Telecommunication Standardization Bureau (TSB) is the sector's secretariat.

[55]The World Telecommunication Standardisation Assembly is the regular four-yearly event that defines the next period of study for ITU-T

Structure of the ITU-T

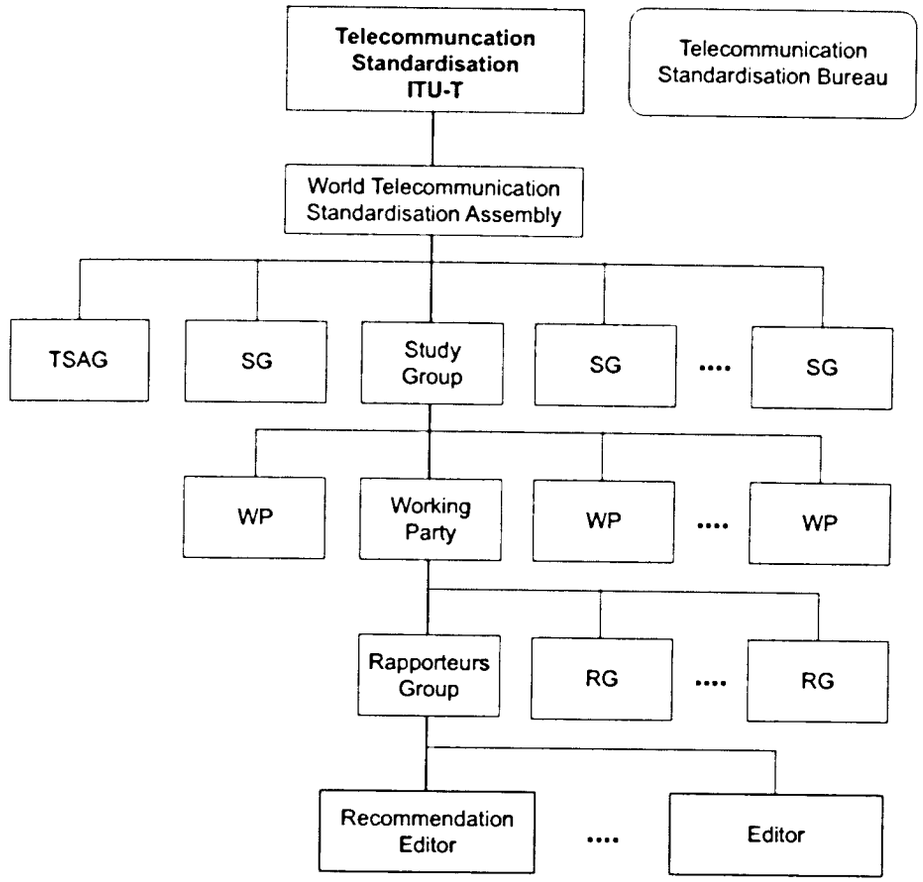


Figure: The structure of the ITU-T (© ITU)

The technical work is managed by 'Study Groups' (SGs[56]). Membership of Study Groups is limited to representatives of ITU Members. During the current study period (2005 - 2008), thirteen Study Groups (SGs) are active. A 'Lead Study Group' is charged with co-ordinating all ITU-T work on subjects that are common to several SGs (such as Quality of Service, QoS).

[56]Study Groups are groups of experts from administrators, the public sector and private organisations.

SGs are established by the WTSA. Their task is to address a number of 'Questions[57]' to be studied. These Questions are approved either by the WTSA or by the SG itself. To establish a new Question, a number of Members must express their commitment to support the work. The SGs then produce draft recommendations within the scope of the Questions assigned to them. An SG may cover as many as 30 Questions. Typically, SGs are further structured into 'Working Parties' (WPs[58]). Representatives of both member countries and other organisational members (e.g. from SIOs) may participate in the technical work at SG level and submit contributions. However, representatives of organisational members need to be approved by their respective member country.
The bulk of the actual technical work is done by 'Rapporteur Groups' (RGs[59]). They determine what Recommendations are required, and develop the draft text for these Recommendations. ITU-T's Recommendations are normative documents and must be formally approved by the originating study group. ITU-T deploys two different approval processes. The 'Traditional Approval Process' (TAP) is used for Recommendations that are considered to have regulatory or policy implications[60]. This process is only used for a small number of Recommendations, notably those that have policy or regulatory implications. Typical approval times are six to nine months.

The standards development process in ITU-T

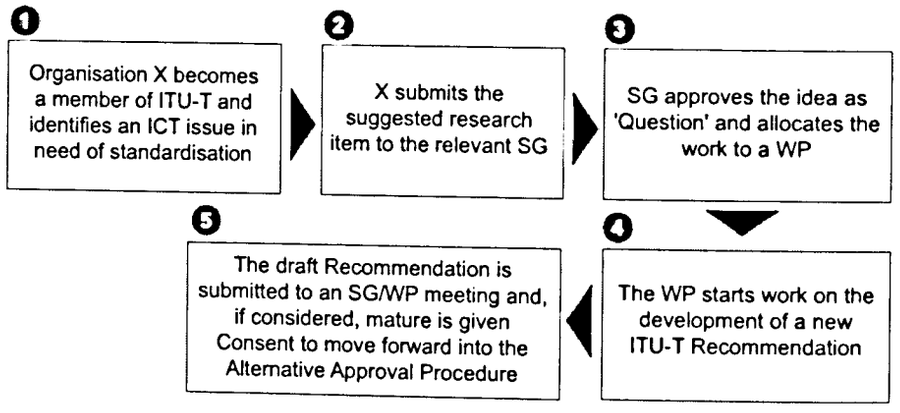


Figure: The standards development process in ITU-T (In 2008, ITU-T produced over 150 new and revised standards. For further information see http://www.itu.int/ITU-T/index.html) (© ITU)

[57]'Questions' are high-level working areas in which the standardisation activities of the ITU-T are structured.
[58]An ITU-T Working Party coordinates a number of Questions.
[59]'Rapporteur Groups' are teams of experts that work on a specific Question.
[60]For a detailed description see http://www.itu.int/pub/T-Res-T.1-2004/en
[61]The Alternative Approval Process (AAP) is the ITU-T's fast-track approval procedure that allows approval within eight weeks.

Today, about 95 per cent of new or revised draft Recommendations are approved through the 'Alternative Approval Process' (AAP[61]).
Once the originating SG has accepted the text of a draft Recommendation, it will be posted on the ITU-T website. Comments may then be made for 4 weeks by ITU-T members. The absence of comments indicates approval.

3.3 ISO/IEC JTC1

The International Organization for Standardization[62] (ISO) is a global, non-governmental federation of national standards bodies from over 150 countries. ISO was established in 1947. Prior to that, standardisation was carried out under the auspices of either the International Electrotechnical Commission (IEC), created in 1906, in the electrotechnical field, or by the International Federation of the National Standardizing Associations (ISA), established in 1926. To adequately deal with all aspects of information technology, ISO and IEC jointly established their Joint Technical Committee One (JTC1) in 1986.

ISO/IEC Join Technical Committee 1

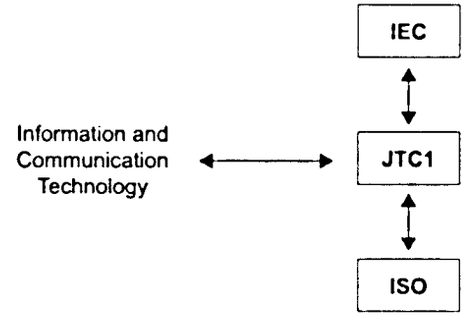


Figure: JTC1 (© Jakobs)

Membership in JTC1 (as well as in ISO) is on a per-country basis, with one organisation - typically the respective national standards body - representing its country. There are full members, correspondent members (that do not actively participate, but are kept fully informed), and subscriber members (that

[62]'ISO' is not an acronym, but a word derived from the Greek word 'isos', meaning 'equal'.

normally represent those countries that cannot afford one of the other categories). Standardisation work is almost fully decentralised, and performed by JTC1's 17 Sub-committees (SCs) and their in excess of 80 Working Groups (WGs).

JTC 1/SC 2 Coded character sets
JTC 1/SC 6 Telecommunications and information exchange between systems
JTC 1/SC 7 Software and systems engineering
JTC 1/SC 17 Cards and personal identification
JTC 1/SC 22 Programming languages, their environments and system software interfaces
JTC 1/SC 23 Digitally Recorded Media for Information Interchange and Storage
JTC 1/SC 24 Computer graphics, image processing and environmental data representation
JTC 1/SC 25 Interconnection of information technology equipment
JTC 1/SC 27 IT security techniques
JTC 1/SC 28 Office equipment
JTC 1/SC 29 Coding of audio, picture, multimedia and hypermedia information
JTC 1/SC 31 Automatic identification and data capture techniques
JTC 1/SC 32 Data management and interchange
JTC 1/SC 34 Document description and processing languages
JTC 1/SC 35 User interfaces
JTC 1/SC 36 Information technology for learning, education and training
JTC 1/SC 37 Biometrics

Individual participants come from the respective national member bodies that are also in charge of providing secretarial services for the committees and groups. In general, participation within any SC is open to every national member body and to all 'A-liaisons'[63] (e.g. ITU-T Study Groups). Development and revision of standards are carried out as 'projects' within a WG. It should be noted that *'The experts act in a personal capacity and not as the official representatives of the P-member or A-liaison organisation by which they have been appointed.'*. ISO itself - being very much a meta-organisation - primarily provides a central coordination entity, does the final editing of documents prior to publication, and maintains an overall schedule. In July 2008, 42 countries participated in the work of JTC1 as P(articipating) members[64], another 42 were O(bserving) members[65]. So far (May 2009), JTC1 has published over 350 standards.

[63]A-liaisons make an effective contribution to the work of a technical committee or subcommittee. They may nominate experts to participate in a WG. B-liaisons are organisations that wish to be kept informed of the work of a technical committee or subcommittee.
[64]P-members have the obligation to vote,
[65]O-members may contribute, but not vote.

Eventually, a decision about a document needs to be taken by voting. This may occur at different levels, and refer to different issues. In any case, however, voting takes place on a 'one country, one vote' basis. A vote will be considered as failed if more than 50% of the P-members have not voted. For a new Work Item Proposal to be accepted, the NP needs to be supported by a majority of all P-members of the associated SC, and at least 5 P-members need to declare their commitment to actively participate in the standardisation work.
Voting is required on CDs and (F)DISs (see Table). In the latter case, for instance, at least two-thirds of the P-members' votes must approve, and at the same time not more than one-quarter of the total number of votes cast may be negative. Final approval has to be given by the full ISO membership. JTC 1 has developed its own set of procedures and guidelines, taking into account the special circumstances of and requirements on IT standardisation. This means that JTC1's processes have been designed to be able to cope with short technology life cycles and the resulting need to produce standards quickly. As a result, the rules specifying the steps towards, for instance, an international standard differ slightly from those adopted by the remainder of ISO. One mechanism deployed is the he so-called 'Fast track procedure[66]' (this mechanism is also used in other ISO TCs; see also stage 4 in the Table below).

The Stages in ISO's Standards Development Process

STAGE #	STAGE	ASSOCIATED DOCUMENT			
		Standard	Fast Track	TR	ISP
1	Proposal	NP			
2	Preparatory	WD			
3	Committee	(F) CD			
4	Approval	FDIS	DIS	DIS	DTR
5	Publication	IS	IS	IS	TR

Figure: The Stages in ISO's Standards Development Process (© ISO)
NP = New Work Item Proposal; WD = Working Draft, (F)CD = (Final) Committee Draft, (F)(D)IS = (Final) (Draft) International Standard; (D)TR = (Draft) Technical Report; (F)(P)(D)ISP = (Final) (Proposed) (Draft) International Standardised Profile

[66]Under this procedure, a document is submitted directly for approval as a DIS to the ISO member bodies.

The most important difference, however, is the implementation of a transposition procedure for 'Publicly Available Specifications[67]' (PAS). Similar to ISO's fast track procedure, this is an even more extensive policy for proprietary specifications to be transposed into international standards. As with the fast track procedure, this reflects the recognised need for a speed-up of the standards setting process and, even more so, the fact that considerable expertise - and almost readily usable specifications - may be available from companies or consortia. The fact that every qualifying entity (see below) may submit a PAS is the crucial difference compared to the fast-track procedure, which only applies to JTC1 P-members and A-liaison organisations.
A PAS is checked for completeness, its availability, stability, and testability. Also, the extent of consensus that the document has already achieved will be considered. This refers to both the originating process (e.g., the level to which user requirements have been incorporated) and the current or likely future level of market acceptance. The specification also has to be aligned with existing JTC1 standards or ongoing work (there must not be any contradicting standards). Upon approval, the PAS submitter gains the right to submit specifications for an initial period of two years, with possible further extensions of five-year periods.
JTC1 has an explicit maintenance policy for its standards. After a maximum of five years each standard is subject to a review. So called 'stabilised' standards are a permitted exception, but even these should be reviewed occasionally (however, no time interval is prescribed here).
In addition to this maintenance process, mechanisms are in place to cope with technical errors and inadequacies. A 'Technical Corrigendum' is issued to correct a technical defect. A dedicated procedure is in place for cases where the proper implementation of a standard depends on a careful and rapid delivery of corrections of defects. Moreover, a published IS may subsequently be modified by the publication of an 'Amendment'. Amendments are issued to publish a technical addition or change. They are published as separate documents, the edition of the IS affected remains in print. ISO's deliverables are available in electronic form through the Internet, albeit at somewhat steep prices. A small selection of standards is available for free.
See *http://www.jtc1.org/* for more information.

[67]JTC1's PAS procedure works as follows: An organisation (that could, for example, be a company or an industry consortium) wishing to have one of its proprietary specifications transposed into an international standard (termed the 'PAS originator') first applies for recognition as a 'PAS Submitter' to the JTC1 secretariat. This application includes information on both the specifications to be submitted and the PAS submitter. Regarding the latter, the originator needs to provide evidence of a cooperative attitude, and of its willingness to pursue standardisation in the JTC1 arena. Also, it needs to demonstrate that the specification has been developed through an open (interested parties may participate) and consensus-based process. Also, the originator (and its members, if applicable; e.g. in the case of a consortium) needs to be prepared to accept the ISO/IEC IPR policy and disclose any patent rights that it may be aware of. Moreover, the originator's standing in relevant industry sectors plays a role, as do its future prospects and its type of legal business entity.

3.4 ETSI - European Telecommunications Standards Institute

ETSI is the European standards organisation that is active in all areas of telecommunications, including radio communications and broadcasting. It was created in 1988 as a not-for-profit organisation. Like CEN and CENELEC, ETSI is recognised by the European Commission as a European Standards Organisation (ESO). Well-known, and globally deployed ETSI standards include GSM (Global System for Mobile communications; formerly: Groupe Spécial Mobile), DECT (Digital Enhanced Cordless Telecommunications), TETRA (Terrestrial Trunked Radio), and DVB (Digital Video Broadcasting). Membership in ETSI is open to any organisation (e.g. company, university, R&D institution, etc.) interested in the creation of telecommunications standards and related services. In May 2009, ETSI membership comprised nearly 700 members from more than 60 countries and across five continents. Manufacturers account for an absolute majority. The major European manufacturers and network operators are present, and are typically represented by more than one branch.
Three types of membership are recognised, 'Full member[68]', 'Associate member[69]', and 'Observer[70]'.
The General Assembly (GA) is the highest decision making authority in ETSI. Its functions include responsibilty for issues relating to policies, budgets, membership, and for external agreements. It is also in charge of taking decisions on the approval of draft standards and other deliverables.

In the GA, voting on technical matters (e.g. acceptance of a draft standard) is done through 'weighted individual voting[71]'. To this end, each company is assigned a number of 'units' (= 'votes'). This number, in turn, is calculated on the basis of a company's 'Electronics Communications Related Turnover ' (ECRT). The ECRT is defined as *'the world-wide turnover generated by all of the member's products and services for which ETSI is competent for developing standards'*. This holds for both Full and Associate members. Accordingly, large companies have more votes than SMEs (SMEs only cast one vote). Likewise, 'User' members have one vote. In 2008, the first 'unit' would cost 6,000 euros, subsequent units 3,800 euros each (the first unit includes the document delivery service). Thus, a large company, e.g. Alcatel, pays over 150,000 euros (and receives 45 votes), an SME pays only 6,000 euros (for 1 vote). Exceptions are made for universities, public research bodies, not-for-profit user associations, and micro enterprises, for which lower fees apply.

[68]Full membership may be obtained by a legal entity that is established in a country falling within the geographical area of CEPT.
[69]Associate membership may be obtained by a legal person not eligible for full membership (e.g., from a country outside the CEPT area).
[70]Observer membership may be obtained by any legal person entitled to become a Full or Associate member.
[71]Weighted National Voting is applied in cases of higher strategic importance, and e.g. on approval of European Standards.

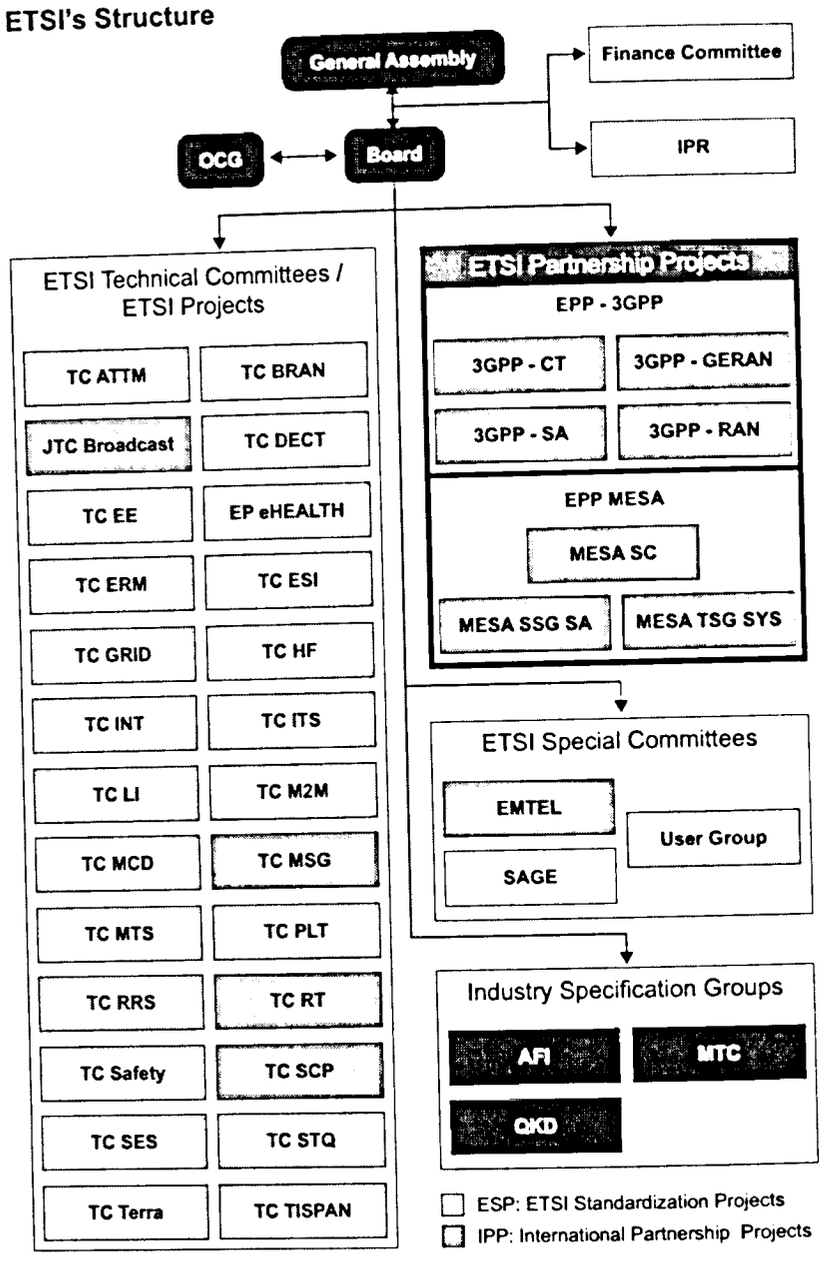


Figure: ETSI's structure (© ETSI)

The technical work of the ETSI Work Programme is structured around 'Work Items' (WIs). The work programme of a Technical Body (TB; i.e. a Technical Committee (TC), an ETSI Project, or an ETSI Partnership Project) consists of the work items for which it is responsible. An ETSI Project aims to achieve a well-defined result within a specific time frame, with a set of well-defined resources. It is established on the basis of a market sector requirement rather than a basic technology. An ETSI Partnership Project (PP) is an activity established when there is a need to cooperate with external bodies and where such co-operation cannot be accommodated within ETSI. A TC is organised around a set of work items addressing a specific technology. It is established on the basis of a technical area rather than a market sector requirement, is semi-permanent, and concerns technology-oriented work of which the outcome can be used by more than one Project or Partnership Project. In addition, a Specialist Task Force (STF) is a means to accelerate the development of urgently needed ETSI deliverables where they are required by the market, thus giving ETSI a competitive advantage. An STF is a group of experts under contract with ETSI with the task to produce the required draft deliverables.

For a proposed new WI to proceed, it is necessary for at least four full and/or associate members to support it and be prepared to contribute to the new work. The adoption of the new WI is confirmed after one month unless a substantial objection is received from an ETSI full or associate member during this period. Participation in the technical work, including the right to vote, is open to all full and associate members of ETSI. A TB should try to reach consensus on all issues. If consensus cannot be achieved, a vote may be conducted. In this case a proposal is approved if 71% of the votes cast are in favour (based on the individual weighting of each ETSI full or associate member). Abstentions or failure to submit a vote are not included in determining the number of votes cast. If a proposal fails to achieve 71%, the result will be recalculated using the votes of ETSI full members only. If the recalculated result achieves 71%, the proposal is approved. In other words, the votes of associate members carry slightly less weight than those of the full members.

ETSI produces a range of deliverables, from Technical Reports (containing mainly informative elements) to European Standards.

ETSI deliverables

European Standard, telecommunications series, (EN)	meets needs specific to Europe and requires transposition into national standards, or when the drafting of the document is required under an EC/EFTA mandate.
ETSI Standard, ES	contains normative provisions, approved for publication by application of the Membership Approval Procedure.
ETSI Guide, EG	contains mainly informative elements, approved for publication by application of the Membership Approval Procedure.
Special Report, SR	contains information made publicly available for reference purposes.
ETSI Technical Specification, TS	contains normative provisions, approved for publication by a Technical Body.
ETSI Technical Report, TR	contains mainly informative elements, approved for publication by a Technical Body.
ETSI Group Specification, GS	a 'lightweight' standard produced by 'Industry Specification Groups'. It is approved and adopted by the Industry Specification Group that drafted it.

Figure: ETSI deliverables (© ETSI)

3.5 3rd Generation Partnership Project (3GPP)

The 3rd Generation Partnership Project (3GPP) is a collaboration agreement that was established in December 1998. The agreement brings together a number of telecommunications standards bodies. The scope of 3GPP is to produce, and maintain, globally applicable Technical Specifications and Technical Reports for a 3G mobile system based on GSM core networks. Partners in 3GPP are classified as either 'Organizational Partners' (OPs) or 'Market Representation Partners'. The former category is open to any SDO with the capability and authority to set standards in a specific nation or region, and an IPR policy compatible with those of the other OPs. Also, all OPs need to commit themselves to the 3GPP scope, and to sign the Partnership Project Agreement. The 'Organizational Partners' determine the general policy and strategy of 3GPP.

3GPP 'Organizational Partners':
- ARIB (Association of Radio Industries and Businesses; Japan)
- ATIS (Alliance for Telecommunications Industry solutions; US)
- CCSA (China Communications Standards Association; China)
- ETSI (European Telecommunications Standards Institute; EU)
- TTA (Telecommunications Technology Association; Korea)
- TTC (Telecommunication Technology Committee; Japan)

Market Representation Partnership is open to organisations that are not SDOs but have the capability to contribute a consensus view of relevant market requirements. They also need to sign the Partnership Project Agreement.
In addition, an organisation that is a member of an OP may apply for Individual Membership. Currently (May 2009), 350 organisations have successfully done so. The work of 3GPP is overseen by the Project Coordination Group (PCG). Among other tasks, the PCG allocates resources, manages the overall work progress, carries out the final adoption of New Work Items, as well as of Technical Specifications and Technical Reports. It also acts as an appeal authority. Decision making at PCG level is based on consensus; voting should only be necessary in exceptional cases. 71% of votes in favour are required for a proposal to be approved (i.e. the process is similar to that adopted by ETSI). The actual technical specification work is performed by four 'Technical Specification Groups' (TSG).

Technical Specification Groups:
- TSG-GERAN: GSM EDGE Radio Access Network
- TSG-RAN: Radio Access Networks
- TSG-SA: Services and System Aspects
- TSG-XT: Core Networks and Terminals

Each Individual Member (i.e. company) needs to obey the IPR policy of its OP and should declare, at the earliest opportunity, any IPRs they believe to be (potentially) essential. OPs, in turn, should encourage their respective members to grant licences on fair, reasonable terms and conditions and on a non-discriminatory basis (FRAND). 3GPP produces two types of deliverables, referred to as 'Technical Specifications' and 'Technical Reports', respectively. There is no clear distinction between these two types; the development processes are identical, and both may be - and have been - transposed into standards by OPs. However, it seems that TRs are of a less formal nature. Where appropriate, the three-stage methodology defined in ITU-T Recommendation I. 130 is employed:
- Stage 1 is an overall service description from the user's standpoint.
- Stage 2 is an overall description of the organisation of the network functions to map service requirements into network capabilities.
- Stage 3 is the definition of switching and signalling capabilities needed to support services defined in stage 1.

Overall, only a small fraction of 3GPP documents have not been transposed into standards by at least one of the OPs. On the other hand, an equally small number have been adopted by all OPs.
For more information see *http://www.3gpp.org/*

3.6 CEN/ISSS

CEN/ISSS (Information Society Standardization System) was created in 1997 as the 'ICT arm' of CEN. Focal areas of work include, for example, e-Business and e-Health, e-Learning, Intelligent Transport Systems, and Security. Work is carried out either in Technical Committees (8, in May 2009; they are not considered here as their rules and procedures are identical to those of CEN) or - less formally - in Workshops (WSs)[72]. In addition, pre-standardisation work takes place in so-called Focus Groups[73]. A WS represents a comparably new type of consensus building mechanism. Basically, it was designed as a middle way between the 'traditional' formal process adopted by the accredited SDOs, and the rather more informal processes typical for many standards consortia and fora.
The procedures for setting up and operating a WS are deliberately kept to a minimum. In fact, ISSS hardly imposes any formal requirements on those who wish to establish a new WS. The major requirement is the development of a business plan which sets out the scope and the time scale of the WS, resources required, an initial list of participants, quantity and scope of the output to be produced, etc. All matters regarding liaisons are also at the discretion of the WS participants. Prospective liaisons should be identified in the business plan. The business plan is subject to comments by the national CEN members and the CEN Management Centre[74] (CMC). These comments should be taken into account. To start the WS the final business plan has to be agreed at the kick-off meeting. CEN, or one of its national member bodies, provides the secretariat for a WS. Apart from that, the individual Workshop enjoys a high degree of autonomy once its business plan has been accepted by CEN. The actual specification work is performed solely by the WS members. CEN Workshop Agreements[75] (CWAs) are the only (externally visible) type of deliverable produced by a CEN WS.

[72]ISSS Workshops have adopted an open process combining the rapid process of informal specification (as by consortia/fora) with the security offered by the formal open consensus of traditional standardisation. The WSs offer direct participation in the standardisation process to all interested parties, including vendors, service pro viders, regulators, users and consumer groups.
[73]A CEN Focus Group is a 'pre-standardisation' mechanism. It produces overview reports on standards-related topics in a given area of activity.
[74]Among other activities, the CEN Management Centre maintains CEN's procedures, assists TCs in their standards development programmes, and manages the budget.
[75]The only requirement imposed by CEN is that a CWA must not be in conflict with existing European standards (ENs). A CWA must be withdrawn if publication of an EN brings the CWA into conflict with the EN. This requirement serves to safeguard the overall coherence of the deliverables adopted by the European standards bodies, and the credibility of European standardisation in the market. The WS Secretariat will notify the CMC if such conflict could arise. It is, however, permissible for a CWA to compete with an EN (or with other CWAs).

They are approved by consensus of the members of the originating WS. It is the responsibility of the chairman to judge if and when consensus has been reached. Consensus is defined according to the ISO definition (ISO/IEC Guide 2:1991). However, in any case consensus is required only at WS level; no other CEN entities are involved.
A comment phase is recommended - albeit not mandatory - following publication of a draft CWA. This is intended to ensure that the development process is as transparent as possible. During this phase comments will be solicited through the normal distribution channels of the national CEN members. The minimum duration of the comment phase is 60 days. The subsequent revision is complete once the Chairman considers consensus to have been reached among the WS participants.
There is no such thing as 'membership' in ISSS. Each individual WS is responsible for bringing together a group of people adequate for its specific purpose. Membership is then limited to this particular WS (as opposed to membership in ISSS). CEN requires every WS to be open to all interested parties. These may include all types of market players (e.g. vendors/manufacturers, service providers, administrations, users, and consumers). However, no interested party must be prevented from joining a WS. The individual WS members are supposed to represent their respective employers. Names and organisations of those participants supporting a CWA's adoption shall be made available on request to purchasers of this CWA. Despite the fact that CEN/ISSS is a European institution, WS members may come from around the globe. They are responsible for the funding and direction of the Workshop, and for the approval of the deliverables.
Workshops typically exist for 1 - 2 years. A WS may or may not decide to maintain its CWAs over time. It may also decide to submit a CWA for the committee-based CEN process, with the aim of transposing it into a formal CEN standard. The lifetime of a CWA is initially limited to 3 years. Unless the former WS participants agree that a renewal of the CWA for a further 3 years is appropriate, it will be withdrawn. CWAs are official CEN publications and are priced accordingly. However, some CWAs can be downloaded for free, but retain CEN copyright. Those made available for downloading are provided on the condition that they may not be modified, re-distributed, sold or repackaged in any form without the prior consent of CEN, and are only for the use of the person downloading them. On 1 January 2009 CENELEC joined ISSS, which was renamed 'CEN/CENELEC ICT Forum'.

3.7 IEEE - The Institute of Electrical and Electronics Engineers

The IEEE is a non-profit organisation, and considers itself as one of the world's leading professional association for the advancement of technology. It has more than 375,000 members in more than 160 countries. 38 societies represent the wide range of IEEE's technical interests. All standards work within the IEEE is performed within the IEEE Standards Association (SA). IEEE members can obtain an additional membership of the SA for a small fee.
Within the IEEE organisation, policy matters are decided within the Board of Governors, while standards matters are decided in the Standards Board. The Standards Board has a number of supporting subcommittees; the most important ones are: NesCOM, the New Standards Committee, RevCOM, the Review Committee, and PatCOM, the Patent Committee.

Entities involved in the IEEE standards setting process

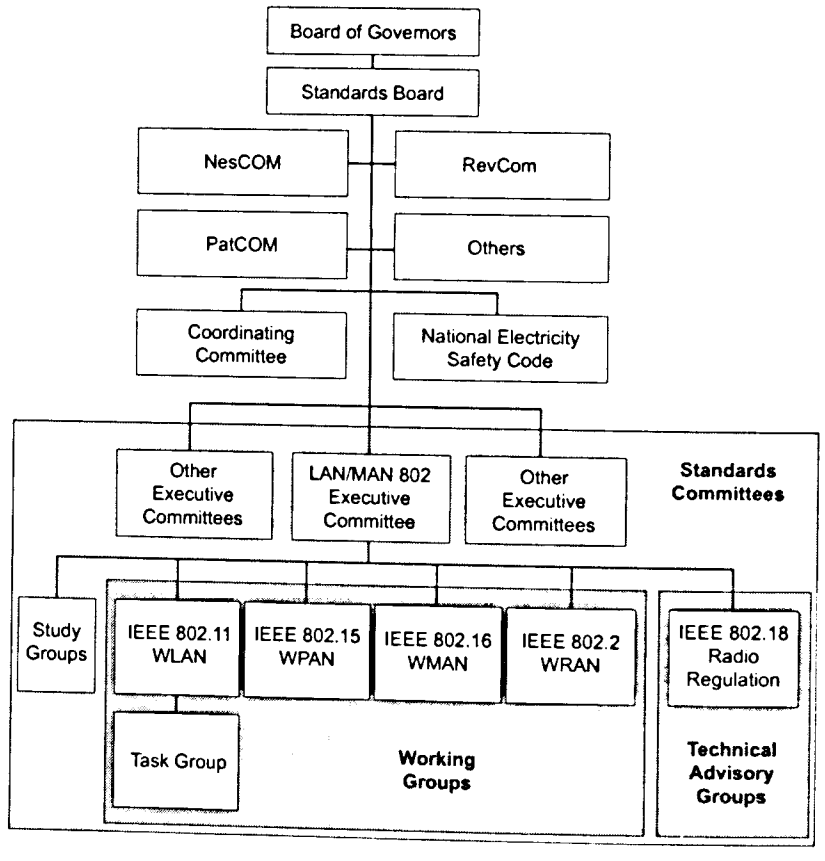


Figure: Entities involved in the IEEE standards setting process (© Jakobs)

Standards Working Groups have the task of developing and maintaining standards on specific topics. Technical Advisory Groups (TAs) advise Standards Working Groups, but do not develop standards. Some have developed Codes of Practice. Study Groups are established with the task of investigating the need to engage in new projects, and when the result is positive, of producing the paperwork to start such projects.
The Executive Committee oversees the overall work of the Standards Committees and is in this case responsible for maintaining the IEEE 802 Policy and Procedures manual. The membership includes all Chairpersons of Standards Working Groups and Technical Advisory Groups.

All standards work is started through a Project Authorization Request (PAR) to be approved by the Standards Board. NesCOM reviews all PARs and advises the Board on the approval process. PatCOM advises on the use of Intellectual Property. IEEE standards may contain patented material, provided that the patent owners have filed a letter stating that they are willing to provide, on request, licences for the use of their patented material against a reasonable fee, without discrimination. The Working Groups are required to solicit information at each meeting to report whether the draft standard contains patented material. If so, the Chair has to solicit the aforementioned letter from the patent owner and PatCOM will review the list of letters received. If, however, the patent holder has not filed the aforementioned letter, the Working Group has to develop the specification in such a way that the patented material will not have to be utilised in the implementation of the standard. In the worst case, when there is no work-around possible, the project will have to be terminated. Once a proposed standard is submitted to the Standards Board for approval, RevCOM will review whether all procedures have been duly executed, including the procedure for potential patented matter.

The actual technical work is performed in the Standards Committees. The Coordinating Committees deal with general subjects such as Terms and Definitions and Quantities, Units, and Letter Symbols. The Standards Committees have to be sponsored by one of the IEEE Societies. In IEEE working groups, membership - including voting rights - is assigned to either an individual or a company. Individuals have to gain voting rights in each Task Group. Depending on the WG, an individual may receive voting rights and become a member as soon as (s)he attends the third of four consecutive plenary sessions. This is intended to prevent individuals from walking in and exercising voting rights, and to ensure that the individual has gained an understanding of the rules and has obtained (some) topical knowledge before casting a vote.
Corporate standards projects represent a recent development; the IEEE now allows for standards to be developed with corporate ('entity') participation. Entities are participants such as academic institutions, corporations, government

bodies, partnerships, consortia, standards-development organizations, etc. This broadening is supposed to the complement individual participation, and to expand the variety of standards-development methodologies within the IEEE.

Voting in IEEE corporate standards projects is on a 'one-company, one-vote' principle. This is different from the individual method of participation, which allows multiple participants from one company or organisation to join a balloting group or working group. This difference can result in a more uniform playing field among the standards participants. Minutes of the meetings of IEEE standards-developing groups are publicly available, as are draft standards. Most approved IEEE standards are available for a fee (some are free of charge).

3.8 IETF - Internet Engineering Task Force

The Internet's standardisation process has changed over the years, from very informal ad-hoc implementations driven by a few enthusiasts to a reasonably - some would say overly - formal procedure today. There are, however, quite a few things that have survived this transformation, most notably the openly available Request for Comments (RFC) series of documents, which provides a forum for discussion on new protocols, mechanisms, and ideas. RFCs are not necessarily standards, but approved Internet standards remain part of this series as well.

'Membership[76]' in WGs is open to all interested individuals, with e-mail distribution lists being used as the major communication medium. In fact, an IETF 'member' is someone whose address appears on one of the IETF's distribution lists. In addition, there are three annual IETF meetings.

The Internet Society (ISOC) oversees growth and evolution of the Internet and the social, political, and technical issues that arise from its use. The Internet Architecture Board (IAB), is responsible for *'...oversight of the architecture of the worldwide multi-protocol Internet'*. The IAB is also responsible for approving appointments to the Internet Engineering Steering Group (IESG).

The IESG, in turn, charters the IETF's Working Groups, where the actual technical standardisation work is done. A working group may be established through the initiative of an Area Director (AD), or it may be initiated by an individual or a group of individuals.

[76]In fact, the IETF prides itself on not having members. Everyone who subscribes to one of the distribution lists is a 'member'.

Entities involved in the Internet's standardisation process

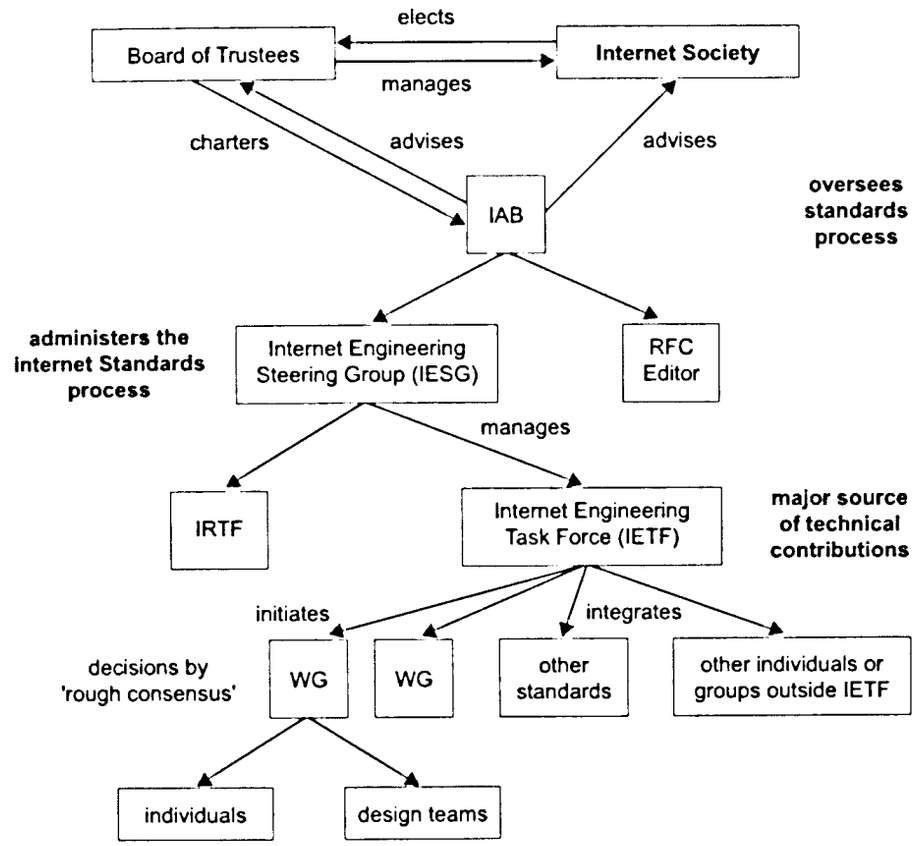


Figure : Entities involved in the Internet's standardisation process (© Jakobs)

The standards setting process has been designed to provide quick solutions to immediate problems. Obviously, this approach tends to produce specifications with a possibly somewhat limited scope. However, extension mechanisms exist in most specifications, enabling integration of, or co-existence with, future standards. Its goals include

- technical excellence,
- prior implementation and testing,
- clear, short, and easily understandable documentation,
- openness and fairness,
- timeliness.

'Rough consensus' of all WG members is required before a specification can proceed on the standards track (as opposed to 'consensus' required by ISO and ITU). In particular, there is no formal voting procedure. If 'rough consensus' cannot be achieved, the IESG will undertake to solve the problem. If this fails, the IAB will be the final authority for an appeal and may, for instance, establish a new working group to consider the matter.
To become an Internet Standard, a specification has to follow the procedure outlined in Figure 17. First, it has to be made available for comments as an Internet Draft for a certain time, typically resulting in a number of revisions. Eventually, the specification may be submitted to the IESG for elevation onto the standards track. Upon approval, the specification is published as a 'Proposed Standard' in the RFC series. It remains at this level for at least six months, thus allowing sufficient time for public consideration and, very likely, revision. After this period, if at least two independent and interoperable implementations exist, the specification is considered generally stable. Upon approval the procedure outlined above is repeated, and the specification will become a 'Draft Standard' for at least four months [Bradner, 1996]. Finally, when significant operational experience has been gained, the specification is raised to the Internet Standard level. If a specification fails to reach this level after two years, it will be reviewed and possibly withdrawn. All decisions relating to advances along the standards track, including final approval and withdrawal, are under IESG responsibility.

Probably the most prominent distinction between the IETF process and those adopted by other bodies is its lesser degree of formality. Most notably, there is no formal balloting involved, neither within the committee nor by any of the other entities that have a say in the process (e.g. the IAB or the IESG). As one consequence of this low level of formalism involved, standards tend to materialise more quickly. This is, however, not necessarily the result of a well-designed process. It is quite possible for a specification to go through numerous versions over lengthy periods of time while still being an Internet Draft, i.e. before being elevated to RFC level. Likewise, no strict upper time limits exist for a document to remain at any given stage of the standards track. Yet, a review of the activity will be initiated ' *...when a standards-track specification has not reached the Internet Standard level but has remained at the same maturity level for twenty-four (24) months, and every twelve (12) months thereafter ...*' [Bradner, 1996].
The need to achieve only 'rough consensus' as opposed to 'consensus' may be considered a major contributor here. Consensus, and due process, are widely considered as the fundamental cornerstones of ITU's and ISO's processes. The latter, which is a prerequisite for the former, was designed to limit arbitrary use of power by some (governing) entity. When applied to the standards setting process, due process means ' *...that any person (organisation, company, government agency, individual, etc.) with a direct and material interest has the right to participate by a) expressing a position and its basis, b) having that*

A rough flow chart of the IETF standards process

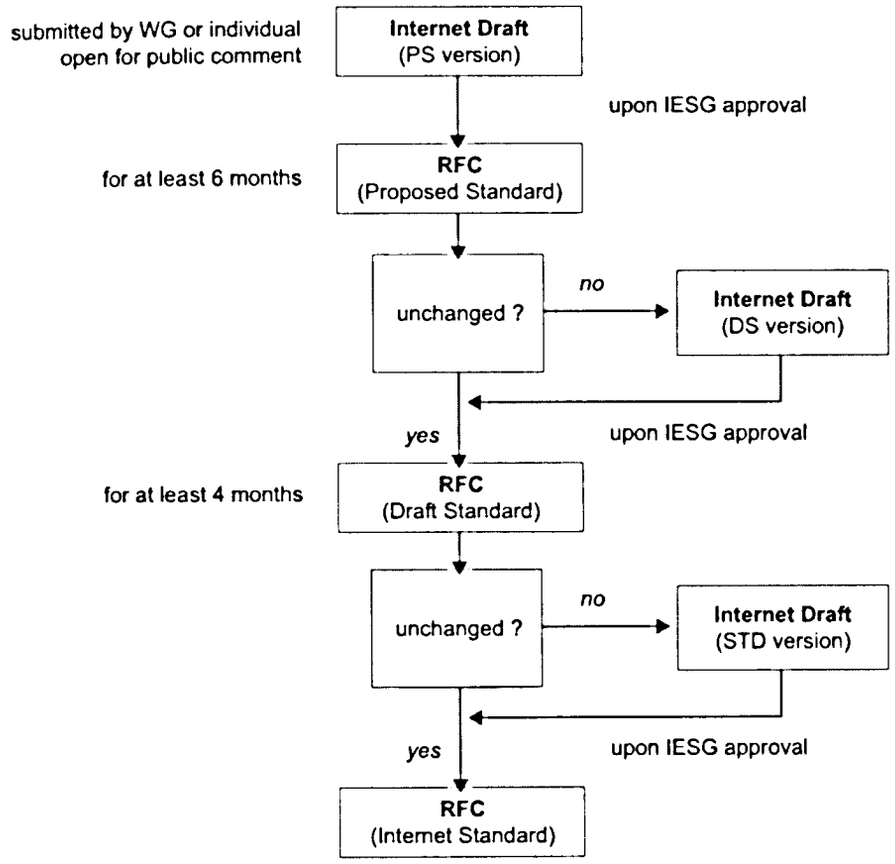


Figure : A rough flow chart of the IETF standards process (© IETF)

position considered, and c) appealing if adversely affected.' [ANSI, 2003]. It guarantees that everyone who might potentially be affected by a standard has the right to participate in the process on equal terms. The latter is achieved when substantial agreement has been reached by all participants. This signifies more than a simple majority, but not necessarily unanimity.
The IETF process makes no mention of 'due process', yet the elements appearing in the definition above apply. Things look slightly different as far as 'consensus' is concerned; the IETF works by the principle of 'rough consensus', which is not quite the same, and very much open to individual interpretation. In particular, which majority is required for acceptance/rejection of a specification has not been defined. Rough consensus has been designed to allow for greater flexibility.

The IETF requires all contributors and participants to disclose, as early as possible, any known IPR, whether their own or held by a third party. Disclosure of IPR should be accompanied by licensing information. This means that the IETF would like to know whether or not permission is granted to implement, use, distribute, etc. IPR-protected technology, and under which conditions. It should be noted that provision of this information is not mandatory. The IETF has two types of deliverables, 'Internet Drafts' and RFCs (Requests for Comments). Typically, the former represent first steps towards the latter. Not all RFCs need to follow the standards track (see Figure: A rough flow chart of the IETF standards process); they may also describe 'Best Current Practices' (e.g. procedures and guidelines) or be 'informational' (e.g. provide background information). Those RFCs that actually are Internet Standards are also assigned an STD number. All documents, including STDs, are freely available to everyone. The IETF as such, as well as some individual WGs, have liaison agreements in place. Their number is currently (mid-2009) limited to around 20 organisations (including, among others, the ITU and some sub-entities, ISO and some JTC1 SCs, and the W3C).
The primary contact on liaison negotiation is the IAB, which also appoints a specific person to such a task if deemed worthwhile. For further information, please see *www.ietf.org*

3.9 OASIS

The 'Organization for the Advancement of Structured Information Standards' is a not-for-profit consortium that drives the development, convergence and adoption of e-business standards. OASIS produces standards for applications such as security, Web services, business transactions, supply chains, and interoperability within and between marketplaces. ebXML, UDDI, and LegalXML are activities under the OASIS umbrella. OASIS was founded in 1993 under the name 'SGML Open' as a consortium of vendors and users devoted to developing guidelines for interoperability among products that support the Standard Generalized Markup Language (SGML). OASIS changed its name in 1998 to reflect an expanded scope of technical work, including the Extensible Markup Language (XML) and other related standards.
The technical work is done in Technical Committees (TCs). At the time of writing (May 2009) some 60 TCs were active; the number of published standards exceeds 70.
The process adopted by OASIS is fairly straightforward. A Technical Committee may be established by any group of at least three 'Eligible Persons[77]'. To start a TC, the group needs to provide the BoD with relevant information. Guidelines on the required information are openly available; among other items, this

[77]In OASIS, an Eligible Person may be an employee of a member organisation or an individual member.

information has to include a statement of purpose, list of deliverables and schedule, identification of other relevant work, etc. Within 15 days this information has to be made available to the OASIS members. Otherwise, the proposal, and an explanation for the rejection, has to be returned to its originator. Rejection of a proposal only occurs if the necessary information has not been provided.

Upon completion of a specification, the TC may approve the work as a Committee Draft (CD). A majority voting procedure is applied. Voting is per individual; companies do not vote at TC level. Approval of a CD requires at least 2/3 of the total membership of a TC voting to approve and no more than 1/4 voting to disapprove. After approval at TC level, a public enquiry phase is prescribed. During this phase, all OASIS members may comment on the CD. A TC may conduct any number of review cycles. Upon completion of the review cycle(s), a Proposed Standard (PS) may be submitted for approval as an OASIS standard. All organisational members have a vote in this process.
If at least 15% of the voting membership approve the PS, and if no negative votes have been cast, the PS will become an OASIS Standard. Otherwise, the originating TC will have the opportunity to submit a revised version for balloting. If, at the end of the second voting period, less than 15% of the voting membership approve, or if 15% or more disapprove, then the specification will not become an OASIS Standard. This does not prevent a later version of the same specification from being submitted again.

In addition to - and irrespective of - the above, a majority vote of the BoD may prevent the creation of a new TC, or a proposed OASIS Standard may be withheld from balloting. However, the BoD is required to give an explanation of its reasons. In case of problems, an appeal process has been defined, which involves either the TC Chairman or the BoD. The BoD is the ultimate authority. OASIS require that at least three member organisations implement a specification before it can be considered for approval as an OASIS Standard. Promoting implementations is considered important.
Basically, OASIS produces two type of 'products' - Committee Drafts and standards, each accounting for around 50% of the output. CD level is retained for various reasons, including, for example, no identified need for further promotion, and lack of three interoperable implementations. Most TCs complete their work within 12 - 18 months. Approval of a specification as a Committee Draft and then as an OASIS Standard will usually take another 4 - 6 months. Of course, some TCs move more quickly than others.
Contributors who are owners of any proprietary rights in a contribution are required to grant an *'unlimited perpetual, non-exclusive, royalty-free, world-wide right and licence'* to OASIS under any copyrights. Also, contributors agree

that no information in their contributions is confidential, and that OASIS may freely disclose any information in these contributions.
Three levels of membership are distinguished; the 70+ 'Sponsors' have the same rights as the around 220 'Contributors'. The differences between these classes are of a promotional nature. Individual membership is the third level; these members may participate in the technical work without restrictions, but are not allowed to vote.
Liaisons with other organisations (including standards bodies) may occur at both organisational and TC level. The former is decided upon by the president of OASIS, the latter is a matter for the TC involved. OASIS has more than 3,000 participants representing over 600 organisations and individual members in 100 countries. Membership comprises users, vendors and technology specialist companies, with a focus on the latter two categories. Virtually all key players from the e-business sector are members of OASIS, many of them as 'Sponsors'. Membership fees are comparably moderate: for 'Foundational Sponsors' the annual fee amounts to USD 44,000 - 50,000. 'Sponsors' pay USD 13,000 - 16,000. At 'Contributor' level the fee is between USD 1,100/year (for not-for-profit organisations) and USD 8,000/year (for companies with 10 or more employees). The individual membership fee is USD 250/year. See *www.oasis-open.org/* for more information.

3.10 W3C

The World Wide Web Consortium (W3C) was formed in 1994 as a response to the increasing demands for an adequate Web infrastructure It aims to lead the technical evolution of the Web by promoting interoperability and encouraging an open forum for discussion. In addition, W3C strives to make the Web a robust, scalable, and adaptive infrastructure.
As of May 2009, the W3C had nearly 400 members. Membership fees vary depending on the prospective member's annual revenues, type, and location of headquarters in the case of an organisation (individuals may also be members). Fees range from less than EUR 1,000 annually (e.g. for a small company in India) to over EUR 65,000 (for a very large company in Western Europe).
Operation of the W3C very much resembles the IETF's process. However, unlike the IETF, W3C does have members, and is generally more formally organised. Moreover, the Director of the W3C has considerable influence within the organisation.
W3C activities are co-ordinated at the top level by the Advisory Committee (AC). The AC is made up of one representative from each W3C member organisation. The Advisory Board (AB) provides guidance to the Team on strategic, management, and legal issues, as well as on process matters and conflict resolutions. However, it does not have any decision-making authority within W3C.

The AB consists of nine elected participants and a Chair, who is generally the W3C Chair.
The mission of the Technical Architecture Group (TAG) is to document and build consensus around principles of Web architecture, and to interpret and clarify these principles when necessary. The TAG consists of eight elected or appointed participants and a Chair, generally the W3C Director. Three TAG participants are appointed by the Director.

Day-to-day work is performed by the 'Team'. It provides technical leadership, organises and manages W3C Activities, and communicates with the Members and the public. The Team consists of the W3C paid staff, unpaid interns, and W3C Fellows.
The W3C Patent Policy governs the handling of patents in its standards setting process. This aims to ensure that standards produced under this policy can be implemented on a royalty-free (RF) basis. This sets the W3C apart form almost all other standards bodies', whose IPR policies typically require licensing under 'Reasonable And Non-Discriminatory' Terms. W3C organises the work necessary for the development or evolution of a Web technology into 'Activities' that must be approved by the AC. Each WG must be part of an approved Activity, and must have a charter. Membership in a WG is open to all W3C members, as well as to external experts (upon invitation by the Director). Each Member (e.g. each company) represented in a WG has one vote, regardless of the actual number of its representatives active in this group.

W3C maturity levels for Technical Reports

Working draft (WD)
A working draft is a document that W3C has published for review by the community, including W3C Members, the public, and other technical organisations

Candidate recommendation (CR)
A candidate recommendation is a document that W3C belives has been widely reviwed and satisfies the Working Group's technical requirements. W3C publishes a candidate recommendation to gather implementation experience.

Proposed recommendation (PR)
A proposed recommendation is a mature technical report that, after wide review for technical soundness and implementability, W3C has sent to the W3C Advisory Committee for final endorsement.

W3C recommendation (REC)
A W3C recommendation is a specification or set of guidelines that, after extensive consensus-building, has received the endorsement of W3C Members and the Director.

Figure : W3C maturity levels for Technical Reports (© W3C)

The process itself, and the outcomes at its respective stages, are visible to the public, who are also invited to comment on the draft specifications. However, much of the ultimate decision power rests with the Director.
The W3C defines that consensus has been reached if a substantial number of individuals in the group support the decision, and if nobody in the group registers a 'Formal Objection'. The W3C process requires Chairs to ensure that groups consider all legitimate views and objections, and endeavour to resolve them, whether they are expressed by active participants of the group or by others. However, overall the wording in the W3C Process Document is typically rather soft (e.g. 'should be followed' rather than 'shall be followed'). Generally, the W3C standards setting process produces 'Technical Reports' (TRs). These may or may not be elevated to the level of W3C 'Recommendations' (i.e. a standard). A TR intended to become a Recommendation has to go through four Maturity Levels.
TRs undergo an extensive public review process. Each WG should publish a new draft of each TR under development at least every three months. In addition, a WG must formally address any substantive review comment about a TR. Once the TR has reached CR status, a 'Call for Implementations' is issued. After gathering implementation experience, the Working Group may request the TR to be advanced to the level of 'Proposed Recommendation'. Subsequently, a 'Call for Review of a Proposed Recommendation' is announced. This represents the second predefined review period.
Once the W3C Director is satisfied that there is significant support from the Advisory Committee, the Team, W3C Working Groups, and the public, the TR is published as a W3C Recommendation. Also, each advancement may only be made with the W3C director's approval.
While a 'Call for Implementations' is an integral part of the W3C standards setting process, there is no requirement for independent interoperable implementations. However, to advance to PR level, every technical feature of a CR must have been implemented. Tracking errors is an important part of a WG's work. Accordingly, a WG charter generally allows time for work after publication of a Recommendation. This is an 'on-demand-process'; every stakeholder may report any detected errors in the specification. Each such report must be published on a WG's 'errata page'. Depending on the type (i.e. severity) of the erratum the solution proposed by the WG may have to go through a new review process. Once accepted as a Working Draft, all Technical Reports are freely available from the WWW at *http://www.w3.org/TR/*. Further information may be found at *http://w3c.org*.

4 Concluding Remarks

ICT standardisation is a complex issue in itself. This complexity is further increased by the almost impenetrable web of standards setting bodies that are developing ICT standards. On the one hand, this has already led to problems regarding the coordination of efforts undertaken by the various SSBs. This lack of coordination may lead to overlapping activities and competing standards, and ultimately to standards wars and market paralysis caused by uncertainty as to which standard will eventually win (i.e. become dominant). On the other hand, would-be contributors to standards setting in the ICT sector are also confused. They need to decide which developments they should contribute to, which SSBs' activities they need to observe and which body to choose for new activities.
In other words, improved cooperation between the individual bodies is becoming increasingly important. This has been achieved reasonably well as far as the 'formal' SDOs are concerned. Yet, these cooperation agreements need to be extended or new agreements established, and standards consortia need to be included as well. Primarily, the SSBs will have to sort this out, but policy makers will also have an interest in this matter and will (have to) act accordingly.
The other aspect that needs to be addressed is the lack of adequate knowledge about ICT standardisation on the part of almost all stakeholders. They not only need to know who is doing what, and where certain standards may be found. They also need to be able, for example, to pick the standards that best meet their needs (not just in technical terms, but also economically), to identify those SSBs that will provide the best platforms for new standards setting activities, and to make at least an educated guess about the outcome of standards wars. This means that adequate education about ICT standards and standardisation is crucial.

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6 Glossary

Alternative Approval Process (AAP)
The Alternative Approval Process (AAP) is the ITU-T's fast-track approval procedure that allows approval within eight weeks.

AB
Advisory Board (World Wide Web Conosrtium)

AC
Advisory Committee (World Wide Web Conosrtium)

AD
Area Director (IETF)

Amendment
An amendment is issued to publish a technical addition or change (ISO)

Andrew Tanenbaum
Andrew Stuart 'Andy' Tanenbaum (born 1944) is an American computer scientist living in the Netherlands. He is best known as the author of Minix, a free Unix-like operating system for teaching purposes, and for his computer science textbooks.

ANSI
American National Standards Institute

Associate member
Associate membership may be obtained by a legal person not eligible for full membership (e.g., from a country outside the CEPT area) (ETSI)

Bluetooth
Wireless Home Network

BSI
British Standards Institution

CCIF
International Telephone Consultative Committee

CCIR
International Radio Consultative Committee

CCITT
International Telephone and Telegraph Consultative Committee. CCITT is the International Telegraph and Telephone Consultative Committee, the predecessor of the ITU-T.

CCIT
International Telegraph Consultative Committee

CD
Committee Draft (ISO)

CEN Management Centre (CMC)
Among other activities, the CEN Management Centre maintains of CEN's procedures, assists TCs in their standards development programmes, and manages the budget.

Contributors
An OASIS membership level.

Consortium
A 'consortium' comprises a number of companies and other organisations collaboratively working towards a common goal (which may be a standard).

Corporate standards projects
A way of developing IEEE standards ('one company, one vote').

CPT
Consumer Project on Technology

CEN Workshop Agreements (CWA)
A CEN 'lightweight' deliverable. CWAs are not CEN standards. They only require consensus bewteen the Workshop participants.

DECT
Digital Enhanced Cordless Telecommunications

De-jure standards
Often used to refer to standards issued by 'formal' bodies (e.g., ISO, ITU, CEN). 'De-jure' is a slightly misleading term since use of these standards is voluntary.

De facto standard
Typically used to denote standards that were either developed through a private standards comnsortium, and/or are proprietary.

Directive 98/34/EC
The European Directive 98/34/EC lays down a procedure for the provision of information in the field of technical standards and regulations. See *http://eurlex.europa.eu/LexUriServ/LexUriServ.do?uri=CELEX:31998L0034:EN:NOT*

DIS
Draft International Standard (ISO)

Draft Standard
A draft standard is an 'intermediate product' of the (formal) standardization process and usually prepared by a technical body (e.g. a working group or a technical committee). This 'prototype' of a standard is fed into the next production stages of the standardization process, e.g. the public inquiry phase or the approval stage. A draft standard may also be published, e.g. as a technical specification.

Dresden Agreement
The 'Dresden Agreement' governs relations between IEC and CENELEC. *http://www.iec.ch/about/partners/agreements/cenelec-e.htm.*

(D)TR
(Draft) Technical Report (ISO)

Due process
The idea that laws and legal proceedings must be fair; everyone has the right to speak and to be heard, and there is an appeal authority.

DVB
Digital Video Broadcasting

E-business
Electronic Business, commonly referred to as 'eBusiness' or 'e-Business', may be defined as the utilization of information and communication technologies (ICT) in support of all the activities of business. Commerce constitutes the exchange of products and services between businesses, groups and individuals and hence can be seen as one of the essential activities of any business. Hence, electronic commerce or eCommerce focuses on the use of ICT to enable the external activities and relationships of the business with individuals, groups and other businesses.

ebXML
Electronic Business eXtended Markup Language. This is a set of XML based standards sponsored by OASIS aiming to provide an open infrastructure to enable the global use of electronic business information.

ECRT
Electronics Communications Related Turnover (ETSI)

E-government
e-Government (short for electronic government, also known as e-gov, digital government, online government or transformational government) is a diffused neologism used to refer to the use of information and communication technology to provide and improve government services, transactions and interactions with citizens, businesses, and other arms of government.

European Standards Organisations (ESO)
The ESOs are CEN, CENELEC,and ETSI

ETSI Group Specification
AN ETSI 'lightweight' standard produced by 'Industry Specification Groups'.

ETSI Guide
An ETSI document containing mainly informative elements.

ETSI Partnership Projects
'Where appropriate, ETSI will base its activities on Partnership Projects committed to basic principles such as openness, clear Intellectual Property Rights (IPR) policy and financial co-responsibility, to be established with partners of any kind (global and regional, Standards Development Organizations (SDOs) and Fora, etc.)' *http://www.etsi.org/etsi_galaxy/worldwide/partnership/partnership_a.htm.*

ETSI Standard
An ETSI document containing normative provisions and approved by the ETSI membership.

ETSI Technical Specification
An ETSI document containing normative provisions and approved for publication by a Technical Body.

ETSI Technical Report
An ETSI document containing mainly informative elements, approved for publication by a Technical Body.

European Standard - Telecommunications series
An ETSI document that meets needs specific to Europe and requires transposition into national standards, or when the drafting of the document is required under an EC/EFTA mandate.

Executive Committee
An IEEE entity that oversees the overall work of the IEEE Standards Committees.

Fast track procedure
Under this procedure, a document is submitted directly for approval as a DIS to the ISO member bodies.

(F)CD
(Final) Committee Draft (ISO)

(F)(D)IS
(Final) (Draft) International Standard (ISO)

Focus Groups
A CEN Focus Group is a 'pre-standardisation' mechanism. It produces overview reports on standards-related topics in a given area of activity.

(F)(P)(D)ISP
(Final) (Proposed) (Draft) International Standardised Profile

FRAND
Fair, Reasonable and Non-Discriminatory

Full member
Full membership may be obtained by a legal entity that is established in a country falling within the geographical area of CEPT.

GA
General Assembly; the highest decision making authority in ETSI.

Global Standards Collaboration (GSC)
The GSC is an initiative of the ITU, ETSI, the United States' Committee T1 and the Japanese TTC, with a number of other regional standards institutions as additional members. It *'...provides for the regular exchange of work programmes and other information in a number of agreed high-interest technical areas, ...'. http://www.gsc.etsi.org/Presentation/home.htm.*

GSM
Global System for Mobile communications (formerly Groupe Spécial Mobile)

HIPERLAN/2
HIPERLAN/2 is a Wireless LAN standard. HiperLAN/2 functional specification was accomplished February 2000. Version 2 is designed as a fast wireless connection for many kinds of networks. These are UMTS backbone network, ATM and IP networks. Also it works as a network at home such as HiperLAN/1. HiperLAN/2 uses the 5 GHz band and up to 54 Mbit/s data rate. Basic services in HiperLAN/2 are data, sound, and video transmission. The standard covers physical, data link control and convergence layers. Convergence layer takes care of service dependent functionality between DLC and network layer (OSI 3). Convergence sublayers can also be used on the physical layer to connect IP, ATM or UMTS networks. This feature makes HiperLAN/2 suitable for the wireless connection of various networks.

HomeRF
'HomeRF' was a wireless networking specification for home devices to be connected to each other. It was developed in 1998 by the HomeRF Working Group, a consortium of mobile wireless companies that included Siemens, Motorola, Philips and more than 100 other companies. HomeRF used frequency hopping spread spectrum (FHSS) in the 2.4 GHz frequency band and could achieve a maximum of 10 Mbit/s throughput; its nodes can travel within a 50-meter range of an access point while remaining connected to the personal area network (PAN). HomeRF allowed both traditional telephone signals and data signals to be exchanged over the same wireless network. Therefore, in HomeRF, cordless telephones and laptops, for example, could share the same bandwidth in the same home or office.

IAB
Internet Architecture Board (IETF). The IAB overses the Internet Standards process.

Information and Communication Technologies (ICT)
ICT denotes both the hardware and software necessary for the operation of telecommunication systems and information technology systems.

ICT Standards Board (ICTSB)
The ICTBS is; *'an initiative from the three recognised European standards organisations and specification providers to co-ordinate specification activities in the field of Information and Communications Technologies'.*

IDABC
Interoperable Delivery of European eGovernment Services to public Administrations, Businesses and Citizens (http://ec.europa.eu/idabc/en/home).

The International Electrotechncial Commission (IEC)
The IEC prepares and publishes International Standards for all electrical, electronic and related technologies.

International Telegraph Union
On 17 May 1865, the first International Telegraph Convention was signed by 20 countries, and the International Telegraph Union was set up.

International Telegraph Convention
On 17 May 1865 the first International Telegraph Convention was signed by the 20 participating countries and the International Telegraph Union was set up to enable subsequent amendments to this initial agreement to be agreed upon. This marked the birth of the ITU.

Internet-drafts
Working documents of the IETF.

IPR
Intellectual Property Rights. These include patents, copyrights, trademarks and trade secrets. Standards may incorporate technology that has formerly been patented. The patent holder is requested to either waive any royalties he might obtain from implementers of the standard ('royalty free (RF) licensing' or agree to license the technology on 'Free, Reasonable, and Non-Discriminatory' terms (FRAND). The latter is the more popular one by far.

IS
International Standard (ISO)

International Organization for Standardization (ISO)
ISO is the world's largest developer and publisher of International Standards. It is a network of the national standards institutes of 162 countries, each having one member per country, with a Central Secretariat in Geneva, Switzerland. ISO is a non-governmental organisation, founded in 1946. 'ISO' is not an acronym, but a word derived from the Greek word 'isos', meaning 'equal'.

ISOC
Internet Society. ISOC is a non-profit organisation founded in 1992 to provide leadership in Internet-related standards, education, and policy.

ISSS
Information Society Standardization System; CEN's 'ICT arm'.
Now called 'CEN/CENELEC ICT Forum'.

ITU-R
ITU's Radiocommunication sector co-ordinates the global use of the radio spectrum.

ITU-T
ITU's Telecommunication Standardization Sector develops Standards ('Recommendations') that define elements in the information and communication technology infrastructure.

ITU-D
ITU's Telecommunication Development Sector works to improve telecommunication infrastructures in the developing world.

JPG
Joint Presidents' Group (CEN/CENELEC/ETSI) coordinates the standardisation policies of the European Standards Organisations.

JTC1
Joint Technical Committee One' is the 'joint ICT arm' of ISO and IEC.

Lead Study Group
An ITU-T entity that co-ordinates all ITU-T work on those subjects that are common to several SGs.

LegalXML
Activity under the OASIS umbrella.

Market Representation Partners
A membership class in 3GPP.

Maturity Levels
Stages which a W3C document has to pass to become a W3C Recommendation.

NSOs
National Standards Organisations

NesCOM
IEEE's New Standards Committee is responsible to ensure that proposed standards projects are within the scope and purpose of the IEEE.

NP
New Work Item Proposal (ISO)

OASIS
The Organization for the Advancement of Structured Information Standards is a not-for-profit consortium that drives the development, convergence and adoption of open standards for the global information society.

O(bserving) members
ISO's O-members may contribute, but not vote. They receive information on the related research and development of the technical committee.

Observer
ETSI's Observer membership may be obtained by any legal person entitled to become a Full or Associate member.

OMG
The Object Management Group. OMG is an international, open membership, not-for-profit computer industry consortium that develops enterprise integration standards.

Open Group
The Open Group is a vendor- and technology-neutral standards consortium works towards enabling access to integrated information within and between enterprises based on open standards and global interoperability.

OSI
Open Systems Interconnection. An standardisation initiative that started in the 1970s. It developed a stack of protocols covering communication functionalities.

PAR
Project Authorization Request (IEEE).

P(articipating) members
ISO's P-members have the right, and the obligation, to vote.

Publicly Available Specifications (PAS)
The PAS procedures are used to transpose proprietary specifications into standards. Typically, an organisation that wishes to submit a PAS has to meet certain criteria, and to agree to follow strict rules during specification development.

PatCOM
Patent Committee (IEEE).

PCG
3GPP's Project Coordination Group manages the project's overall work progress.

Plenipotentiary Conference
Plenipotentiary Conferences are the top policy-making body of the ITU. They are held every four years. Among other activities, they set the ITU's general policies, and adopt four-year strategic and financial plans.

PS
Proposed Standard, a stage in the standardisation processes of the IEEE, IETF, and OASIS.

Questions
Questions are high-level working areas into which the standarisation activities of the ITU-T are structured.

RAND
Reasonable And Non-Discriminatory

Recommendations
The standards published by the ITU are referred to as 'Recommendations', in order to highlight their voluntary nature.

RevCOM
Review Committee (IEEE).

RGs
ITU-T's Rapporteur Groups are teams of experts that work on a specific Question.

RF
Royalty-free; a form of IPR licensing.

RFCs
Request for Comments. This is a series of documents describing a variety of aspects relevant to the Internet. They are produced by the IETF (Internet Engineering Task Force), the Internet's standards setting body.

RosettaNet
RosettaNet is a private consortium that aims at defining standard processes in the electronic business domain.

SA
Standards Association, the 'standards arm' of the IEEE.

SC
Sub-committee (ISO).

Standards Developing Organisations (SDOs)
The term typically 'SDO' denotes 'formal' standards bodies such as ITU and ISO.

SGML
SGML (Standard Generalized Markup Language) is a language for defining markup languages such as HTML and for specifying the rules for tagging elements in a document. SGML itself is not a markup language; instead, it is a language to create markup languages. SGML supports the definition of markup languages that are independent of hardware- and software. SGML was developed and standardized by the International Organization for Standardization (ISO), which published it in 1986. Because of SGML's complexity, HTML and XML were developed as simplified subsets of SGML for use on the Internet.

SIOs
Scientific or Industrial Organisations; a member category in ITU.

Standards committee
An entity in the IEEE's standardisation process.

Standard's maintenance
The activity of keeping individual standards or standards repositories as a whole up-to-date and functional. This may include the revision or phasing-out of obsolescent standards, the introduction of new standards, or the deletion of obsolescent standards classes/categories.

Standards track
In the IETF, not all RFCs are standards. Those documents that are suppsoed to eventually become Internet Standards need to proceed through the various stages of the standards track.

STD series
In the IETF, the documents of the STD-series are the actual standards that pretty much govern the Internet and describe its functionality. All STD documents are RFCs, but not vice versa.

STF
Specialist Task Force; an entity in ETSI's standardisation process.

SGs, Study Groups
In ITU, Study Groups are groups of experts from administrations, the public sector, and private organisations. Each SG develops Recommendations in response to a number of Questions, each of which addresses technical studies in a particular area of telecommunication standardisation.

TAG
Technical Architecture Group; a high-level entity in the W3C's standardisation process.

TAP
ITU-T's Traditional Approval Process is deployed for Recommendations that are considered to have regulatory or policy implications.

TA
Technical Advisory Groups are entities of the IEEE's standards setting process.

TC
Technical Committees; entities in the standardisation processes of ISO, ETSI and OASIS.

Technical Corrigendum
An type of ISO deliverable issued to correct a technical defect.

Technological lock-in
Once an organisation has decided to install a (proprietary) system, it may experience major difficulties if this decision has to be revised at a later stage, and a different system is to replace the old one. The more severe these difficulties are, the stronger the 'lock-in' into the old technology will be.

The International Telegraph Union
The International Telegraph Union, the predecessor of the ITU, was set up as a treaty organisation in 1865 by twenty European countries.

TETRA
Terrestrial Trunked Radio, developed by ETSI. The purpose of the TETRA standard was to meet the communication needs of Professional Mobile Radio (PMR) user organisations in fields such as public safety, transportation, and military.

Tetrapol
A Cellular Trunked Radio System, a direct competitor to Tetra.

TIA
Telecommunications Industry Association.

TRs
Technical Reports; a type of deliverable of ETSI, ISO, W3C, and 3GPP.

TSAG
Telecommunication Standardization Advisory Group, an ITU decision-making body.

TSB
Telecommunication Standardization Bureau, ITU-T's secretariat.

TSG
The technical specification work in 3GPP is performed by Technical Specification Groups.

TTC
Telecommunication Technology Committee; Japan

UDD
Universal Description, Discovery and Integration; an activity under the OASIS umbrella.

UN/ECE
The United Nations Economic Commission for Europe.

Vienna Agreement
The 'Vienna Agreement' provides the rules for co-operation between CEN and ISO. *http://www.wipo.int/treaties/en/classification/vienna/trtdocs_wo031.html.*

WD
Working Draft, a stage of ISO's standardisation process.

WG
Working Group; an ISO entity where the technical specifications are developed.

Work Programme
The work programme of a Technical Body (TB; i.e., a Technical Committee (TC), an ETSI Project, or an ETSI Partnership Project) consists of the work items for which it is responsible.

Working Parties (WPs)
An ITU-T Working Party co-ordinates a number of Questions.

Workshops (WSs)
ISSS Workshops have adopted an open process combining the rapid process of informal specification (such as by consortia/fora) with the security offered by

the formal open consensus of traditional standardisation. The WSs offer direct participation in the standardisation process to all interested parties, including vendors, service providers, regulators, users and consumer groups.
World Telecommunication Standardization Assembly (WTSA)
The World Telecommunication Standardization Assembly is the regular four-yearly event that defines the next period of study for ITU-T.

Wireless World Research Forum (WWRF)
The WWRF was founded in 2001. It develops directions for strategic future research directions in wireless communications, and contributes to work done within numerous standardisation bodies.

World Wide Web Consortium (W3C)
The World Wide Web Consortium (W3C) is the leading organisation for the development of Web standards. In May 2009, the W3C had nearly 400 members.

XML
Extensible Markup Language; a set of rules for the encoding of electronic documents.

3GPP
The 3rd Generation Partnership Project (3GPP) is a collaboration agreement that was established in December 1998.

3G mobile system
Third Generation (3G) is the term used to describe the latest generation of mobile services which provide advanced voice communications and high-speed data connectivity, including access to the Internet, mobile data applications and multimedia content. The International Telecommunication Union (ITU), working with industry standards bodies from around the world, has defined the technical requirements and standards as well as the use of spectrum for 3G systems under the IMT-2000 (International Mobile Telecommunications-2000) program.

802.11
A set of standards for Wireless Local Area Networks.

7 Key questions

- What is a standard according to ISO?
- What are the 'Vienna Agreement' and the 'Dresden Agreement'?
- What does the Global Standards Collaboration do?

Nicole Riemer

Abstract

This teaching unit deals with the discussion of efficiency in formal standardisation, which - due to the growing importance of standards for industry and the economy - is becoming increasingly highly charged. In order to answer the question as to how formal standardisation can be organised more efficiently, the functions and essential features of formal standardisation will first be presented and distinguished from standardisation by industrial consortia.
The institutional framework of formal standardisation provides, on the one hand, a guarantee of the benefits of standardisation in terms of welfare economics, while at the same time also presenting special challenges for efficiently coordinating the actors in standardisation.
It is particularly the formal standards bodies with their demand-oriented service and resources, qualified personnel and suitable instruments of coordination who are called on to support the interested parties of standardisation in their work.

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1 Introduction

'Formal standardisation has an image problem' the current Director of the Deutsches Institut für Normung e.V., or DIN for short, admitted when confronted with prejudices such as being overly bureaucratic and having a mania for rule-making.[1]

Industry is a particularly fierce critic of the lengthy and complex decision-making processes of formal standardisation, which in turn demand resources of both time and finance from their participants.[2]
Demands for an adaptation of the speed of preparing standards to market requirements are particularly strong for areas with an especially high level of technical innovation and short development periods for products, e.g. those from the field of information and communications technology (ICT).[3] The ICT industry states that the development times for standards are some three to four times longer than the life cycles of the products for which they are drawn up.[4]
The long-standing dissatisfaction with current formal standardisation practice is increasingly shifting attention towards the discussion of standardisation efficiency. Both the interests of industry as part of global competition and the political demands on standardisation have given rise to the 'competitive imperative' to define standards more efficiently.[5]

In this context, critical consideration of the existing structures particularly focuses on formal standards bodies. Because of their crucial role in standardisation, they are increasingly facing criticism for the way in which they work.[6] Formal standards bodies are attributed with a slow, bureaucratic and inflexible way of working, which does not match the market requirements or the requirements of those parties interested in standardisation.[7]

Due to their critical appraisal, companies increasingly tend to avoid the time-consuming processes of formal standardisation.[8] However, so as not to miss the first-mover advantage in competition, the business actors become involved in highly specialised industrial consortia which, particularly at European and international level, line up alongside the conventional standards bodies and carry out work according to their own principles. The establishment of industrial consortia corresponds with the wish of industrial enterprises to be able to independently determine the group of participants in the consensus process and thus pursue their aims, e.g. of reaching a consensus more quickly. Compared

[1] Ramge 2004, 72.
[2] Wegberg 2004.
[3] Cargill 1999, Falke 2000, 128.
[4] DIN 2002, 6.
[5] Swann 2000, V.
[6] Swann 2000, V, Commission of the European Communities 1990, 5, Bonner/Potter 2000, 11.
[7] Wegberg 2004, 18; Egyedi 1996, 108, Egyedi 2001.
[8] Wegberg 2004, 28.

with conventional, i.e. formal standardisation, participating in standardisation within an industrial consortium is seen by enterprises as a 'resource-saving alternative'[9].
Because of the growing popularity of industrial consortia, a considerable fall in the involvement of interested parties in formal standardisation is to be expected, which firstly leads to a reduction in available resources and secondly - and this is significantly more serious - to a crisis in the legitimacy of standards based on consensus[10].
Consequently, formal standards bodies in particular see themselves as key actors in the situation of demonstrating possible approaches for efficient standardisation.
Before possible approaches to more efficient standardisation are outlined individually, the essential features of formal standardisation and the associated challenges will be explained.

2 The creation of standards under the auspices of formal standards bodies

In actual fact, there is a widespread belief that an army of civil servants is at work in public authorities on repeatedly passing new regulations in order to create binding and occasionally somewhat pedantic regulations for the everyday routine of their fellow beings. However, this image contains a general misconception.
Formal standards are not created within a public authority but in collaboration with a large number of different actors, known as the interested parties. During a formal standardisation process, these parties take part cooperatively and with equal negotiating rights as regards the necessity for and the contents of a standard.
The interested parties can be classified into the following groups of actors:

- companies of all sizes from all industries
- consumers, users and employees who are directly affected by the standardisation
- associations and representatives of companies, consumers and employees, such as trade unions, chambers of industry and commerce
- the scientific community, such as universities or research institutes
- organisations involved in the field of accreditation and certification
- national, regional and international standards bodies
- state and supranational bodies with sovereign powers, such as the European Union (EU) or the state.

[9]Vries 1996, 6, DIN 2002a, 3.
[10]DIN 2002a, 9f, Krechmer 2003, 1, Vries 1999, 65.

The interested parties are each equipped with a different set of resources that open up certain courses of action to them in the standardisation process.

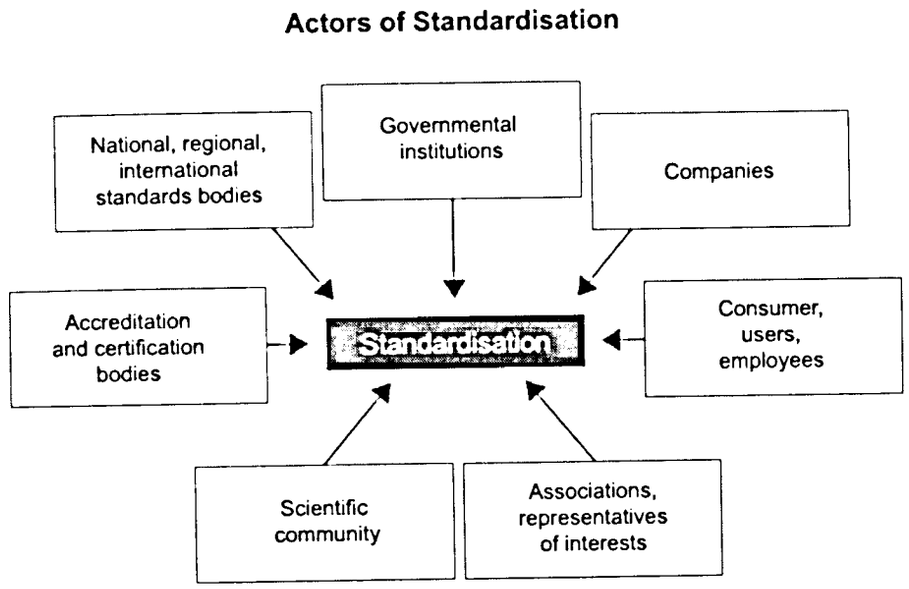


Figure: Actors involved in standardisation (Source: DIN 2005)

The formal standardisation process itself can be subdivided into four development stages:

- A Proposal Stage
- B Preparatory Stage / Committee Stage
- C Enquiry Stage / Approval Stage
- D Publication Stage

A detailed account of the individual formal standardisation phases can be found in the chapter entitled 'Development of Standards' in this book. This looks closely at the interests of the individual groups of actors and how they behave or interact in characteristic situations during the standardisation process.

The formal standardisation process is organised under the auspices of a formal standards body.
It very soon became apparent at the time of the industrial revolution, in Taylorism at the beginning of the 20th century, that there was potential for rationalisation in creating uniform parts, products and processes.

DIN standardisation process

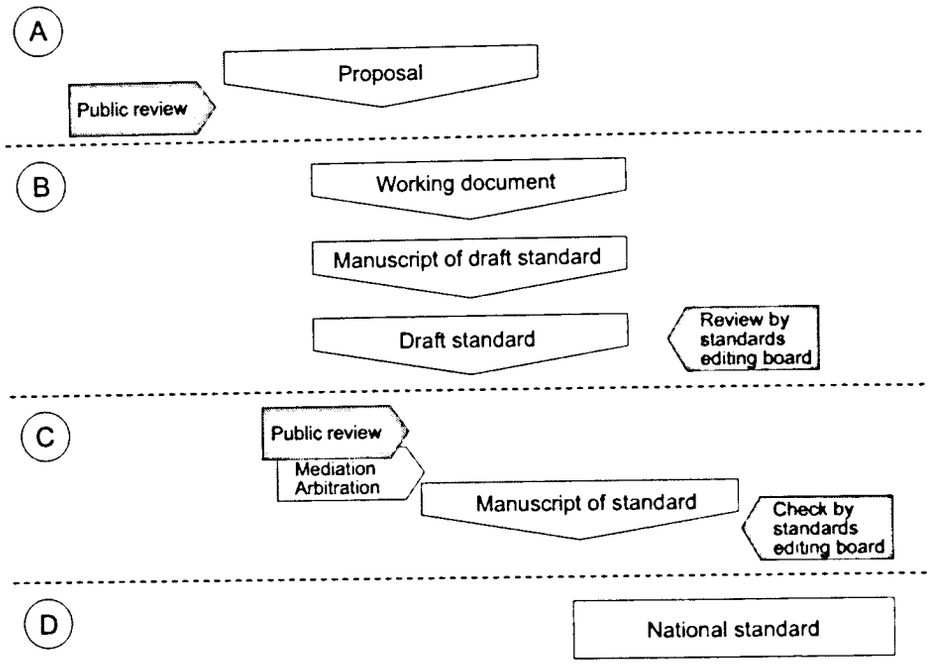


Figure: Standardisation process (Source: DIN 2005)

Consequently, since the beginning of the 20th century, formal standards bodies have been forming at national level, which offer the interested parties a forum to create standards valid for the entire nation. These organisations were often founded on associations that represented professional interests extending beyond individual companies. Today formal standards bodies are always organised separately from the professional associations so as to guarantee their independence and freedom from bias.[11] So-called 'acknowledged' standards bodies (which are largely identical with formal standards bodies, as formal standards bodies are usually acknowledged and vice versa) are characterised by the fact that they are legitimised or furnished with a special status by the state, such as having the right to sole representation of their country in international standards bodies.

[11]Nicolas/Repussard 1995, 15.

With the objective of economic integration, the beginning of the 20th century initially saw the founding of international standards bodies as a means of creating cross-border standards. At the beginning of the 1960s, they were followed by the supranational or regional standardisation bodies as support for the projected the Single European market.

National, European and International Standards Bodies

inter-national	www.iso.org	www.itu.int	www.iec.ch
supra-national	www.cenorm.be	www.cenelec.eu	www.etsi.org
national	www.din.de	www.afnor.org	www.bsi -global.com

Figure: International, European and selected national standards bodies (© Hesser/Czaya/Riemer)

In Germany this formal standards body is an association. The Deutsches Institut für Normung e.V., or DIN for short, is therefore not a government agency but, with its employees, merely assumes coordinating functions for its associated members, the interested parties of standardisation.

Formal standards bodies offer a platform on which the interested parties of standardisation can gather privately as part of an autonomous organisation away from the market sphere and state compulsion to negotiate in structured standardisation committees on the state of the art in engineering, and to document this as a standard.
Standards development thus takes place under the auspices of the formal standards bodies in a large number of technically specialised decentralised committees and working groups, which are in turn made up of representatives of the interested parties.

At national level the standardisation committees bring together the original heterogeneous interests of the previously mentioned actors in standardisation, while supranational (European) and international standardisation committees have a national consensus previously negotiated in national mirror committees as their input.
Employees of the formal standards body coordinate these standardisation committees.

Structure of Formal Standardisation Organisations

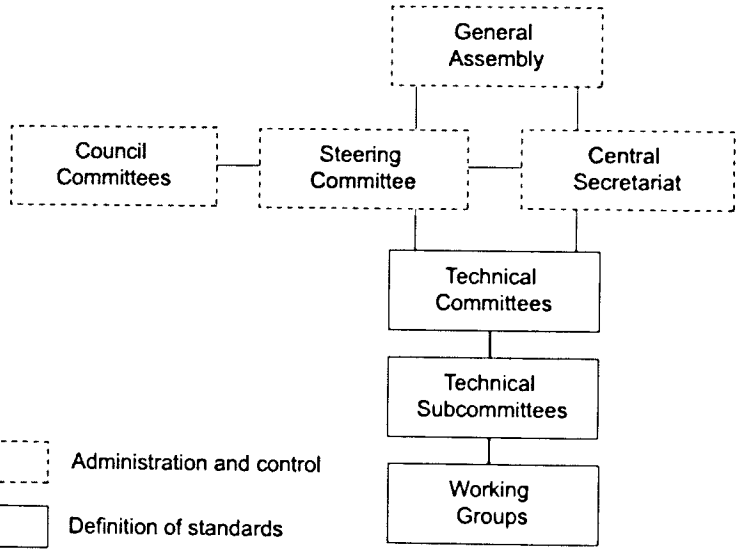


Figure: Structure of standards bodies (Source: Thiard/Pfau 1992, 67)

Regardless of the field in which they work and their geographical domains, formal standards bodies organise their activities in line with a series of basic principles. The work of DIN, for example, observes the following principles:
- Voluntary nature
- Open to the public
- Participation of all interested groups
- Uniformity and freedom from contradictions
- Application of the consensus principle in standardisation procedures
- Orientation towards the state of the art
- Directed towards the economic conditions

- Directed towards the common good
- International character

The same or similar content can be read in rules of procedure and statutes of many other national, supranational and international standards bodies. As mentioned before, formal standards bodies that conduct their work in accordance with the above principles are usually formally acknowledged by the state. In actual fact these basic principles of standardisation form a point of reference which can be applied to assess other forms of standardisation, especially those provided by standards consortia.
An explanation of these basic principles can also be found in the chapter entitled 'Development of Standards' in this book.

Principles of formal standardisation

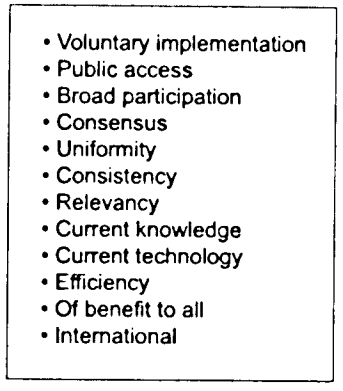


Figure: Principles of formal standardisation (Source: DIN 2005)

Formal standardisation differs from standardisation within industry consortia in that it exercises these basic principles while consortia may deviate from those principles in one way or another.
Industry consortia or also fora are created on the initiative of various companies and other stakeholders who form a cooperation partnership in order to draft and establish a standard.[12] Consortia are often founded ad hoc in order to meet a need for standardisation that has arisen, and then frequently disband quite simply after the standards have been successfully drawn up.

[12]David/Shurmer 1996, Krechmer 2003.

The establishment of industrial consortia corresponds with the wish of industrial enterprises to be able to independently determine the group of participants in the consensus process and thus pursue their aims of reaching a consensus more quickly and having greater freedom in the exploitation of property rights.[13] Industry consortia often focus on short-term, realistic objectives such as business success.[14] Consequently, industry consortia often arise particularly when certain market opportunities accompany the standards they are developing.
Usually everyone does not have the right to be a member of a consortium. Because of their high level of specialisation, consortia are often subject to at least implicit access restrictions. One aspect making relatively efficient drafting of standards possible is therefore the fact that such consortia generally have a homogeneous composition (e.g. companies from one industry) and that largely identical interests prevail among the members.

While formal standards bodies are accused of working too slowly and hence of being poorly equipped to meet the rapidly changing market requirements, industry consortia are confronted with the charge of not being open and hence undemocratic.[15] The price that the consortia pay for an accelerated standardisation process can generally be said to be that their output, the 'industry standards' or even the 'de facto standards', do not have the same status or the same legitimacy as formal standards.[16]

As industrial consortia and formal standards bodies, despite their differences, are often perceived by the interested parties as competing institutions, and industry standards in some cases have widespread acceptance, the relationship between the formal standards bodies and the consortia is ambivalent.[17]
As described at the outset, one example of how the competitive situation, at least in the lateral sense, is expressed can be found in the fact that formal standards bodies have been offering standardisation processes and corresponding forms of publication resembling those of industrial consortia.

With their so-called fast-track procedure, the formal standards bodies are reacting to the growing criticism of their working methods.[18] However, as some principles of formal standardisation like the public inquiry stage are omitted in order to achieve a swifter procedure, the new standardisation concepts differ fundamentally from the traditional processes of formal standards bodies.

[13]Cargill 1999, DIN 2002, 9.
[14]In actual fact, the majority of consortium members who perform an active task do belong to the marketing division of the company they represent. These members then strive to increase the speed in order to achieve business success at an earlier stage. However, this is not intended to mean that consortia do not deal with technical solutions. Many studies describe the situation of bypassing the more political process of standardisation in order to concentrate on achieving the technical solution (Kim 2004, 70).
[15]Cargill 1999, Willingmyre 1996, Wegberg 2004.
[16]'De facto Standards' are standards that because they are so widespread on the market are implicitly binding for all companies. This is also referred to as 'de facto validity'. (David/Greenstein 1990, 4, Glanz 1993, 28)
[17]Blum/Jänchen 2002, 41ff.
[18]DIN 2002 , 10f, Falke 2000, 130ff.

Consequently, the specifications thus obtained cannot claim the legitimised status of an acknowledged/formal standard.[19]
Hence, giving up the standardisation principles merely gives the new services of the standards bodies a consortial appearance, which inevitably intensifies the competition with industrial consortia yet does not affect the basic problem of efficiency in formal standardisation processes.[20]

This connection is also confirmed in the demands of the OECD, which pose the question relating to the future of standardisation as to which institutional constellation would enable the fair participation and satisfactory coordination of the many interests to be achieved.[21] Here the OECD report links the increasing shift of standardisation to the international sphere as part of the globalisation process as well as the altered demands on standardisation with the need to adjust the way that formal standards bodies view their roles.[22]
The focusing of the activities of formal standards bodies on providing guidance, the central exchange of information, guaranteeing an open, transparent standardisation process, encouraging and enabling the interested parties to cooperate and organise themselves is concentrating attention on their coordinative function.[23]
In understanding the future role of formal standards bodies, the following view applies: 'If a sense of "system" is to be maintained at all, however, four centralised functions must be preserved and expanded:

- Provision of guidance...
- Project linkage...
- Compliance...
- General governance...'.[24]

Even the formal standards bodies themselves recognise the deficits in terms of coordination: 'New forms of establishing consensus in cooperative and virtualised groups cast doubt on traditional, highly formalised and hierarchical decision-making processes.' 'A paradigm change appears to be urgently required for the entire... standardisation process.' "Operationalisation..." can be achieved by "...developing innovative, network-centred rather than hierarchical structures with a high speed of reaction and the development of new forms of cooperation and establishing consensus".[25]

[19]Commission of the European Communities 1998, No. 11, ANEC 1999, 7.
[20]Wegberg 2004, 30.
[21]OECD 1996, 34.
[22]OECD 1996, 23.
[23]OECD 1996, 7f.
[24]OECD 1996, 35.
[25]DIN 2003, 13, DIN 2004, ISO 2004, Bahke 2004, Zhao 2004.

3 Challenges for more efficient formal standardisation

While in practice individual actors question the need for democratic legitimation of standardisation, there exists little doubt about the principles of standardisation within the realms of academic discussion.[26]
Accordingly, one approach to a solution for greater efficiency in preparing standards is viewed in academic circles not in the abandoning of democratic principles but, instead, in efficiently designing coordination as part of the established way in which standardisation is conceived.
In order to derive the requirements for more efficient standardisation and appropriate approaches to a solution, the following section will therefore analyse the challenges confronting the formal standards bodies as part of their coordination function.

3.1 The complexity of the standardisation structure

Generally it may be said of the need for coordination that the greater it is, the greater the complexity of the standardisation structure will be. Social systems such as standardisation committees become all the more complex as the number of elements they possess increases and the differences between these elements rise.[27]
As described above, standards unlike laws, are not legally binding but acquire their legitimisation on the basis of the broadest possible level of consent that is formed between all relevant actors - supposedly of equal status - on one set of facts. A standard for the electronic exchange of patient files, for example, has to take due account of the interests of the state health policy, the hospital administrations, the developers and users of the software and, of course, the patients.
At the same time, this is where the key challenge lies for an efficient coordination of standardisation. While the broadest possible consensus between the interests of the actors maximises the acceptance, use and hence the benefits of a standard, the costs of reaching a decision with this principle are high.
In Germany alone, more than 28,500 voluntary standardisation experts from the ranks of the interested parties are involved in representing their different standardisation interests within over 3,400 working committees.[28]
Due to their practical relevance in markets that are changing with increasing rapidity, it may be assumed that these standardisation activities will continue to spread.[29] The many standardisation committees and the specific heterogeneity in the composition of their members results in problems with the law

[26]OECD 1996, 24.
[27]Luhmann 1980, Sydow/Windeler 2001, 136.
[28]DIN 2009.
[29]Kleinaltenkamp 1990.

of large numbers. The means that coordination becomes all the more difficult as more actors with heterogeneous interests are involved.

Yet it is not only the number of actors but also their complex relationships with one another that are the cause of the high coordination demand in standardisation.
Apart from the high number of persons requiring coordination in the standardisation committees, various types of direct and indirect relations exist between the individual standardisation actors, some of which are extremely complex and interdependent. On the one hand, the coordination demand is due to the great distances that exist in terms of space, time, interpersonal aspects and culture, which have to be overcome, particularly at the supranational and international levels of standardisation. On the other hand, extended integration can be expected to produce an increase in heterogeneity of the characteristics of the actors in standardisation and hence in the diversity of aims promoting opportunism.

The process of agreeing on a joint consensus is usually described in the literature on standardisation as an example of horizontal (pooled) interdependency.[30] This is also relevant to the extent that in the public inquiry stage, for example, coordination merely takes place horizontally on the proposed standard.[31]
First, however, the actors in the standardisation committee have to appraise, within the context of a complex negotiating situation, what objectives the other actors have, what chances there are for agreement on a common standard and what risks they are running in terms of prior concessions, for example.
Admittedly, the coordination pressure in standardisation is not as high as for example in innovation processes; nevertheless, it may be assumed that economic risk, technical complexity and time restrictions also cause the actors involved in standardisation to coordinate their activities during the early phases of the standardisation process in order to minimise economic risks.[32] One common feature of the standardisation process and the socially negotiated genesis of technology is that they both initially have to undergo a design phase in which the parameters of a new technology or of a new standard are specified. This phase is concerned with a multidimensional decision-making problem. Beyond a certain stage of maturity, the decision-making problem diminishes to the dimension of adoption or non-adoption.[33]

[30]Messner 1994, 567.
[31]Cf. the chapter entitled 'Development of Standards' in this book in connection with the standardisation process.
[32]Barthel 2001, 30f, 84.
[33]Reimers 1995, 44.

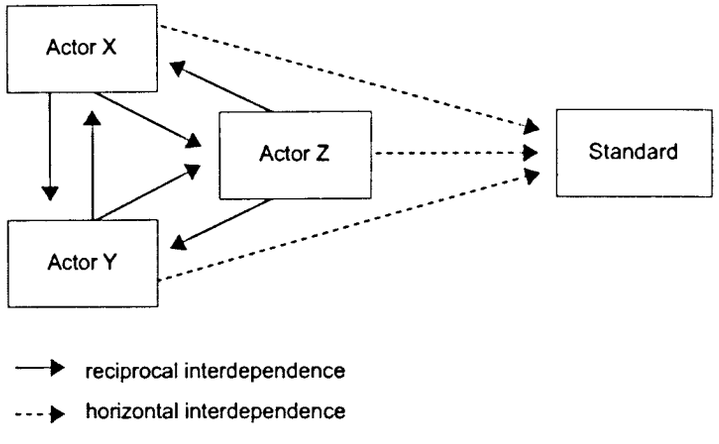


Figure: Horizontal and reciprocal interdependency in the preparation of a standard (Source: Barthel 2001, 42)

3.2 Standards as public goods

(Formal) standardisation belongs to those areas of public policy in which the state seeks cooperation with associations in the field of technology for readily understood reasons of self-interest. In this respect, the state particularly makes use of the information potential and expertise accumulated in the standardisation committees for purposes of legislation, jurisdiction and administration.[34]
In actual fact a fundamental problem lies in mobilisation of the required expertise.
Here, this so-called mobilisation problem is largely a result of the free accessibility of standards, which also means that they cannot be withheld from those actors who do not take part in their creation. This non-excludability of what may be called non-payers characterises standards as public goods.[35]

[34]Marburger 2005, 11.
[35]Another feature of collective or public goods lies in the non-rivalry of their consumption, i.e. they can be used simultaneously by several or many economic units, without their quantity diminishing detectably (Schumann 1992, 40f). However, the fact that the actors participating in the standardisation committees also receive information benefits (at least in terms of time) occasionally results in insinuations that standards are club-based property (Blum/Jänchen 2002, 29).

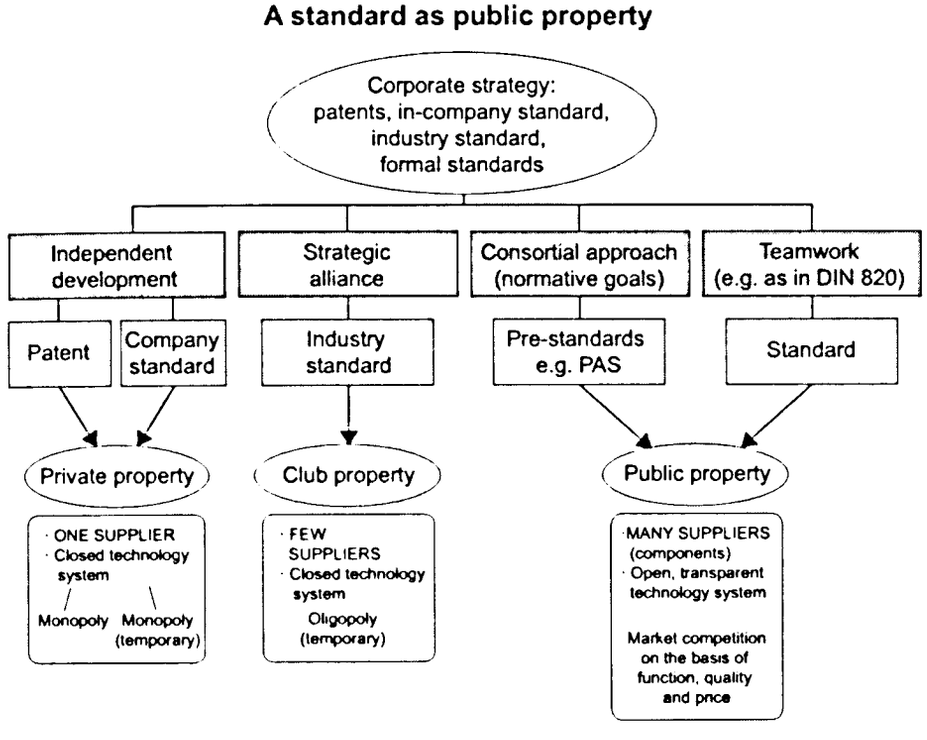


Figure: The standard as public property (Source: DIN 2007, 3)

As both involved and non-involved users profit to an equal extent from the benefits of applying a standard, regardless of whether they have participated in its creation, actors behaving in an individual and rational manner have a correspondingly low tendency to provide time, money and knowledge for standardisation. Consequently, when viewed from the perspective of maximising the benefits for each individual actor, it is more advantageous not to take part in the setting of standards.[36]
In addition to this aforementioned problem of free riding, actors who do not allow their know-how to serve as input for public standardisation still have the opportunity to exploit their knowledge within the framework of standardisation by industry consortia.[37]

[36]Wiesenthal 1987, 437f, Werle 1995, 63f, Besen/Saloner 1989, 181, Foray 1994, 10.
[37]Kim 2004, 177.

Due to the character of standards as public property and the associated externalities despite the wide range of motives for actors to take part in standardisation, it cannot be expected that a self-regulated organisation of standardisation will come about without compulsion and selective incentives.[38]

Whenever the conditions for the spontaneous generation of standardisation processes are not fulfilled, materialisation of the standardisation processes depends on the existence of supporting institutional structures that close what may be called the institutional gap.[39]
The term 'institutional gap' characterises a situation in which no actors can be found among the users of a potential standard to set a standardisation process in motion but there are nevertheless actors who would join the standardisation process once instigated.[40]
The materialisation of standardisation processes depends crucially upon whether there is a third party with an external interest in the creation of the standard and initially in the existence of a supporting institutional structure that will take over the coordination function necessary to overcome the institutional gap.[41]
(In standardisation responsibility for this function lies with the formal standards bodies.)

3.3 Standards as a representation of social consensus

Because of their foundation in natural sciences, standards are commonly regarded as a technical specification for defining and documenting the state of the art in technology and thus give the appearance of being an objectively ascertainable quantity.[42] If this were the case, the critical hurdle in standardisation would merely be mobilising the expertise. Knowledge and not interest would then be the decisive criterion.[43] If this reference to interest did not exist, it would not matter who produced the standards; it would depend only on the expertise.
In actual fact, however, formal as well as consortia standards are the results of a negotiation process. They come into existence as a compromise determined by the experts involved observing various reference values, particularly those of an economic and hence extra-technical nature. Consequently, standards are not in any way restricted to the factual description of technical functional relationships but are ultimately always political decisions.
It is precisely because of these extra-technical reference values that the drafting of standards is so full of conflict. Yet it is also precisely this connection of standards with interest that explains why such great value is placed on the participation of all those affected by the standard.[44]
However, this is also where the characteristic participation paradox of standardisation lies.[45] On the one hand, it is desirable (and a defined principle of standardisation) to include as many relevant actors in the consultations and decisions relating to a standard. On the other hand, this leads above all to the agreement problems becoming more complex, and the risk of a blockade or stalemate situation rises.[46]
In addition, an altered demand on standards increases the heterogeneity of the actors in standardisation and hence the degree of complexity in the coordination of standardisation. The increasing convergence of technology promotes functioning compatibilities that extend across sectors, particularly in the computer and telecommunications industry.[47]

On the one hand, collective standardisation is based within the framework of institutionalised cooperation, namely the organised coming together of the various groups of actors within the standardisation network for the common aim of generating a benefit for the common good through the development and establishment of standards. On the other hand, this relationship of cooperation within standardisation is characterised to some extent by large distances in terms of space and time but also and especially in interpersonal terms.
Despite the cooperative intentions, competition between the heterogeneous actors simultaneously exists during the cooperation process: 'The consensus process in the international standardisation business is, as easily surmised, more or less like a political or economical power game although the topics discussed are mostly of a purely technical nature.'[48]
The advancing internationalisation of standardisation as well as an increasing importance of aspects of market and competition strategy during the process of establishing consensus contribute to an increase in the complexity of coordination.[49] The differing interests of the discussion partners lead to time-consuming discussions in the cooperation negotiations, particularly when reaching agreement on strategically important, technical details, and to a slowing down of the process of establishing consensus required for drafting a standard.[50]

[38]Externalities arise because the goods produced by pooling resources cannot be restricted to those making contributions. Participation in the collective action thus has a (positive) externality for the so-called free riders.
[39]Reimers 1995, 157, 177.
[40]Reimers 1995, 157.
[41]Reimers 1995, 178, Werle 2001, 2.
[42]CEN/CENELEC 1998, 1.4, 3.4.
[43]Voelzkow 1996, 188.
[44]Voelzkow 1996, 190.
[45]Barthel 2001, 99.
[46]Schmidt 1998, 164.
[47]Pfeiffer 1989, 11ff.
[48]Takahashi/Tojo 1993, 535, cf. also Fomin 2002, 79f.
[49]Approx. 80 per cent of all current standardisation activities that take place in DIN today are directed towards the European and international level (DIN 2007, 22, Eickhoff/Hartlieb 2002, 172). The decline in purely national standardisation projects is set to continue in favour of European and international standardisation projects, which will become increasingly important (DIN 1998, 6f, Falke 2000, 9).
[50]Swann 2000, 46ff.

The following figure illustrates the heterogeneous motives of the groups of actors taking part in standardisation.

Motives of standardisation participants

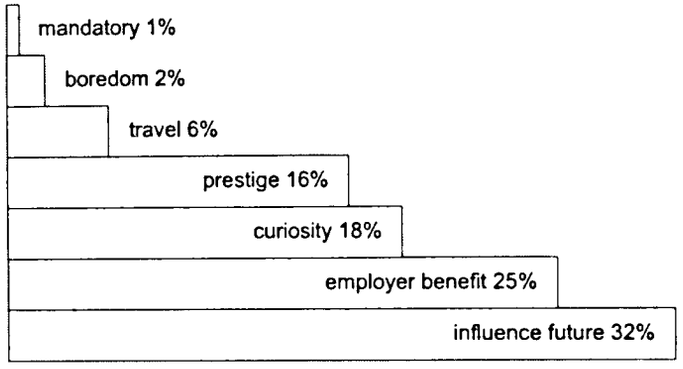


Figure: Motives of standardisation participants (Source: Spring et al. 1995, 233)

Standardisation committees must have the ability to make decisions, this means transferring the heterogeneity of the members' interests to a homogeneous unit, which should as far as possible be in harmony with the relevant public interests in each case.[51]
Consequently, the decision-making rules within the standardisation network must ensure that the actors refrain from maximising their own benefits in favour of the general public good. To achieve general acceptance of standards, the interests also have to be harmonised so that the definitions made not only satisfy the standardisation actors but are also appropriate from the view of the actors not included.

[51]Voelzkow 1996, 187.

3.4 Voluntary application of standards

Standards remain without effect if they are not known, generally accepted and applied. Accordingly, the benefit of standards does not arise solely through their existence but only within the context of their application. Within this process, the benefits of standards rise as the number of users increases due to the existence of network effects.[52]
Consequently, it is also important to consider the diffusion conditions of standards as well as the general acceptance as part of an efficient coordination process. Standards bodies carry out the enforcement of standards as part of their functions of disseminating and promoting the use of standards.
Because standards as such are not legally binding and their implementation initially incurs costs for their users, a voluntary willingness to comply among the addressees of the standard can by no means be assumed.
Even if, for example, the absence of conformity to standards in products or services should become generally apparent as part of a public reminder, any disadvantages in real economic terms for the company would tend to be an exception since breaches of a standard often remain below what is known as the stimulus threshold because of their complex theoretical principles.[53]
Hence another task of standards bodies is to generate the binding effect of standards among their target groups through other motivational and/or material incentives.[54]

To summarise: the challenges described can be employed to define requirements for the efficient coordination of standardisation. The key features in the way standardisation is conceived place demands on formal standards bodies, particularly in terms of their ability to mobilise, make decisions and generate commitment.[55]

[52]Kindleberger 1983, 337.
[53] Roßkopf 2000, 47, Schmidt-Preuß 1997, 160. More common than real economic effects on the sales markets, however, are the financial reactions of the capital market if the breach of the standard was not in keeping with the shareholders' interest. Less problematic here is the fact that the average investor will often be less well-informed and will not notice the breach of the standard or will not be able to evaluate it correctly (Damrau 2003, 91).
[54]Voelzkow 1996, 191.
[55]Cf. Voelzkow 1996, 185ff.

4 Possible solutions for designing efficient standardisation through the standards bodies

The preceding chapter explained that the coordination of standardisation cannot manage without a steward.[56] As stakeholder group size and complexity of standards preparation increase, so does the need to reach agreement between the actors in standardisation through specialised network agents with sufficient coordination skills.
The coordinating ability of these 'third parties' is not only connected with one condition for the creation of but also generally for the efficiency of standardisation processes.[57] Werle also emphasised that the institutional features of standardisation organisations affect the speed, exclusivity, costs and market acceptance of standardisation.[58]
Hence this section intends to answer the question as to how standards bodies can be efficiently constituted in accordance with the requirements for their central role as coordinators.

4.1 Demand-oriented services

Formal standards bodies are at the centre of the discussion on efficiency. The state uses them in order to coordinate the interested parties of standardisation as part of their self-government within the framework desired or specified by the state.
Generally described as "reciprocal agreement of individual activities within a labour-sharing system towards an overriding general objective...", coordination in the context of standardisation means matching the heterogeneous interests of the participating actors within the process of collectively reaching a consensus.[59] Under this condition, the coordination function is at the same time a necessary and undisputed prerequisite for the process of negotiation and establishing a consensus in standardisation.[60]

Coordinating standardisation involves all those tasks required to shape the collaboration between the members throughout their entire cycle of cooperation.[61]
Correspondingly, within the standardisation network, the coordination function accompanying the standardisation process or accompanying the functions of formal standardisation bodies is to be viewed as a cross-functional task.

[56] see chapter 3.2.3.2.
[57] Reimers 1995, 178.
[58] Werle 2001, 2.
[59] Hoffmann 1980, 200f, 302, Kosiol 1968, 77, Ritter 1998, 46.
[60] Schmidt/Werle 1998, 23, 108f.
[61] Peitz 2002, 227, Otto 2002, 87.

Coordination of standardisation as a cross-functional task

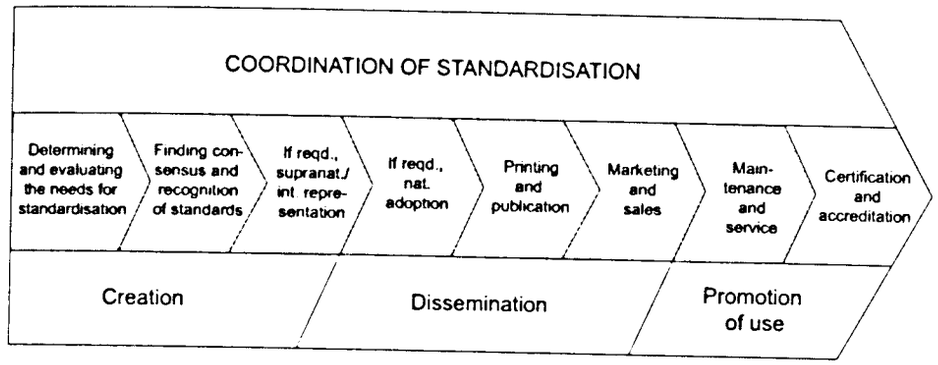


Figure: Standardisation coordination as a cross-functional task (Source: Riemer 2010)

As the collective ability to act in standardisation and hence the efficiency of the standardisation depends crucially on the coordinating ability of standards bodies, the latter have to ensure that a suitably demand-oriented coordination is in place.
In the context of the political standardisation network, demand-oriented coordination does not mean, as is often implicitly assumed, that it is the task of the central standards body to represent the interests of the different actors in standardisation, but merely to aggregate these interests authentically as required by the state, and hence to guarantee a corresponding plurality of values.[62]
At this point it is necessary to clarify which specific services are needed to promote the requirements described above relating to the complex relationship structures, the mobilisation of experts and their know-how, the guaranteeing of a consensus-forming process in which all interests including those of the public are integrated, and not least the binding effect of standards among users.

As the success of standardisation depends to an important extent on the ability of standards bodies to mobilise the actors and bring them together in a suitable way, it would appear useful to find an appropriate way of securing this person-related component in the functional system of standardisation coordination.[63]

[62] Cf. Section 2.
[63] The requirements on efficient coordination in terms of the ability to motivate, make decisions and generate commitment are largely personal.

The familiar management process of differentiation can be employed here; it focuses on people management in addition to the customary task management.[64] Basically, it is therefore possible to distinguish between the objective coordination of tasks and behaviour-oriented coordination of people.
Reiss also refers to this distinction and from this jungle of coordination functions develops the coordination of tasks and members as two central spheres of coordination:[65] At the centre of task coordination are the performing processes of the network. People coordination is relationship management, which is directed towards current or potential network participants. This subdivision inevitably does not separate very clearly, but does offer a basis for further considerations on a systematic approach to the coordination tasks.[66]
The tasks of coordinating standardisation can be correspondingly systematised into task coordination and people coordination.

Performance profile of standardisation organisations

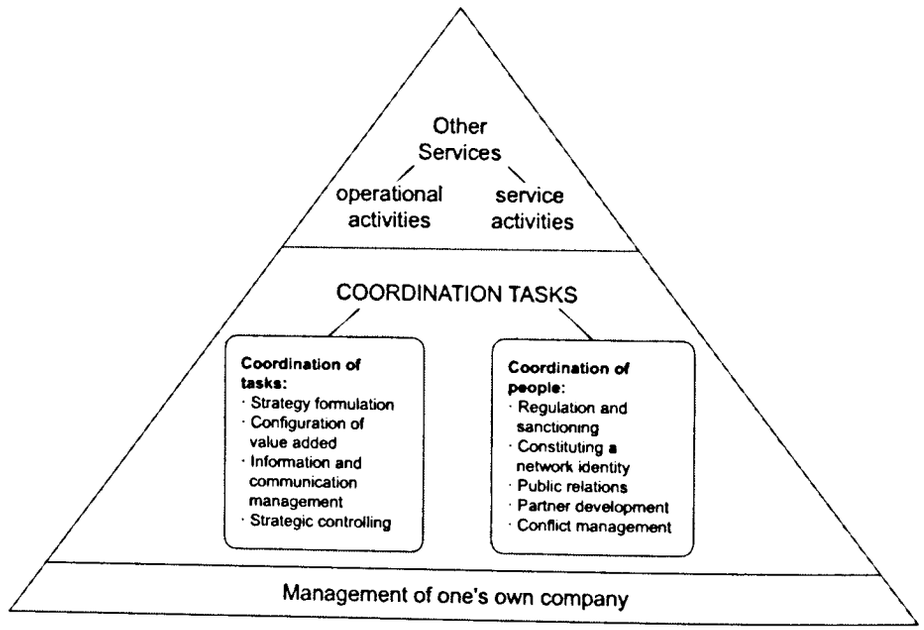


Figure: Service profile of the standards body (Source: Riemer 2010)

[64]Farey 1993.
[65]Reiß 2000, 230.
[66]For the interdependencies of task-related and interaction-related systematics, cf. Tröndle 1987, 87ff.

Task coordination involves items such as strategy formulation, value-added configuration, information and communication management as well as strategic controlling. Within the context of people coordination, the standards bodies are responsible for the task of regulating and sanctioning, constituting a network identity, public relations and partner development as well as conflict management.
The increasingly dynamic standardisation environment and the changing underlying conditions that accompany it, e.g. in terms of globalisation and expansion of new economic areas, growing convergence of technology or shortened development times and product life cycles, call for a target-oriented arrangement of all standardisation activities within the framework of a standardisation strategy.
Their implementation firstly requires corresponding operational and administrative structures to be created, and secondly for suitable actors to be brought together with the relevant resources and abilities for the success of the standardisation project.
To implement the standardisation project efficiently, but also to legitimise it, supporting information, communication and controlling measures are necessary to ensure that the method of working is transparent.
The area of activity including regulation and sanctioning, which organises the collaboration of the standardisation actors, is similarly directed towards transparency.
While it may be possible to formally regulate sanctioning, this does not apply to the motivation to become involved in standardisation. As formal codes and rules for controlling the actors quickly approach their limits, it can be useful to supplement these formal contracts with psychological contracts. This can take place within the context of a normative constitution. The picture of a responsibility community can be sketched here within the framework of a network identity.
Standardisation needs public communication. Although the benefit of standardisation for society has been demonstrated and quantified in impressive studies, because of their discreet charm standards rarely display their effect in the public eye. Instead, the benefit of a standard tends to become apparent by negation, namely by its non-existence.
Formal standardisation (as well as standards consortia) relies on the voluntary commitment and the expertise of specialists. It is particularly when standardisation experts take on coordinative tasks as well that efficient standardisation requires technical qualification to be supplemented by knowledge of methods in terms of handling negotiations, project management or in the commercial sphere. Guaranteeing this is the task of partner development.
The consensus-based negotiation and agreement methods in standardisation also demand a mediation system to ensure that, despite any conflicts that may occur, the standardisation actors can continue to work together in a spirit of trust.

Apart from performing coordination activities, there is also an option for the standards body to offer other services as part of its performance model.[67]
According to the degree of integration, this may include performances within the primary value-added process (operational activities). An example that may be quoted here are the current activities of standards bodies in publishing standards.
On the other hand, it may also involve service activities, which in a wider sense are part of its core activities as a standardisation coordinator.[68] Examples of such activities may include the passing on of market research information, searches on patent law, training sessions or consultancy services on standardisation within companies. In the context of standardisation it is important to make sure that these activities, which to some extent have an intended economic goal, are in keeping with the requirements of the corresponding legal form[69].

4.2 Coordination skills and role profiles

In order to implement the coordination activities described, it is not sufficient to merely conduct a wholesale transfer of the responsibility for coordination to the standards bodies, but to express support for the actors who have the necessary resources in technical and organisational terms.

Within the context of coordination ability, the distinctive resources can basically be classified into two skill dimensions: the technical and the social coordination skills.[70]
Specialist economic, legal and information technology skills within the coordination process are not only restricted to a knowledge of IT integration, commercial knowledge for evaluating the network performance and the determination of transfer prices or a necessary knowledge of marketing, but also, in the generalised sense, affect technical skills for mastering cross-functional processes such as product development, order processing and logistics.[71]
Social skill expresses itself in the ability to establish and maintain favourable relationships with customers, banks, suppliers and other stakeholders. As well as relationship management, other abilities addressed are in the fields of handling negotiations, mediating conflict-solving processes and building trust.[72]
In addition to the technical and social skills, it is also assumed that, as part of what are known as methodological skills, there will also be an ability and

[67]Winkler 1999, 156.
[68]Reiß 2000, 225.
[69]Compare here for example the integration or the spinning off of economic activities of DIN as part of its constitution based on the law of associations (Terner 2005).
[70]Reiß 2002, 14. Similar to the distinction made by Reiß into technical and social network skill, Hansen et al. distinguish between organisational and personal skills (Hansen et al. 1997).
[71]Reiß 2000, 14, Reiß/Beck 1995, 38f.
[72]Reiß 2000, 14.

willingness to adopt a target-oriented, planned approach by applying acquired thought techniques and working procedures.[73] Methodical working includes independent design and evaluation; it demands personal initiative and creativity.
As the individual tasks of standardisation coordination demand technical as well as methodical and social skills, both Reiss and Ritter have extended this systematic structure of coordination skills as part of their skills profiles.[74] Four skills clusters of coordination can be described based on the two models: leadership skills, configuration skills, integration skills and change management skills.

Skills dimensions in the coordination of standardisation

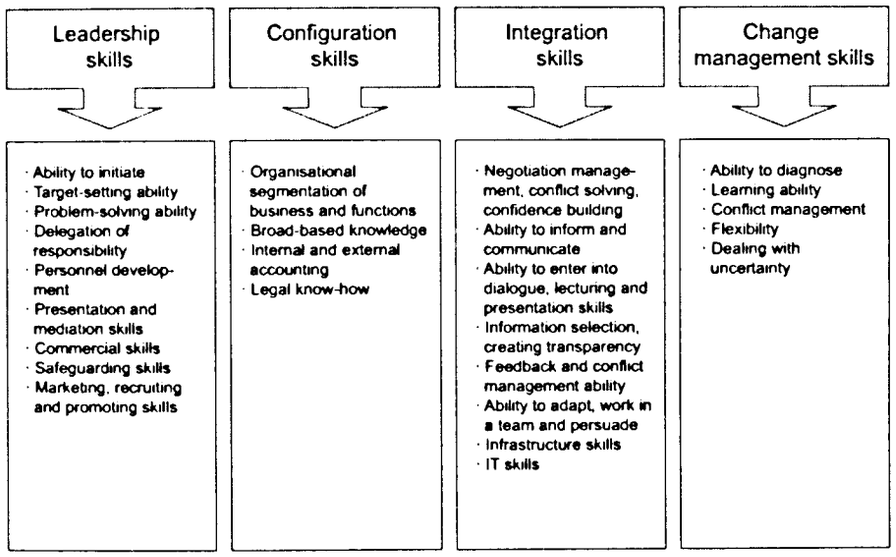


Figure: Service profile of the standards body (Source: Riemer 2010)

Due to its breadth and heterogeneity, the skills spectrum for standardisation is unlikely to be found in one single person.[75] Consequently, different personal roles have to be developed, each of which focuses on one special skills area in the field of standardisation coordination. Possible coordination roles may be that of the architect, the lead operator and the caretaker.[76]

[73]Bader 2000, 39, Esser 1997, 31, Ott 1995, 181..
[74]Cf. Ritter 1998, 160ff, Reiß 2001, 149ff.
[75]Reiß 2000, 14.
[76]Snow/Miles/Coleman 1992, 14ff.

Architects, also conductors, have the task of establishing the network on an organisational and technical level and developing it further, as necessary. They are therefore also regarded as enablers. The role of lead operators is linked with the tasks of operational network management. Operationalising the configuration of value added, including partner selection and distribution of tasks are their core business, as are coordinating the partners by means of information and communication as well as regulation and sanctioning. The caretaker has a prominent role in networks. He acts as a coach for network members. He mediates crises and conflicts, ensures a high level of information and improves the transfer of knowledge.
Standardisation coordinators are allocated a skills profile and hence a coordination role according to the coordination task they have taken on.
These coordination roles thus act as a form of institutionalising skills profiles, not only as part of job descriptions with a corresponding external effect but also generate an attachment among the actors to their task of coordination.[77]

4.3 Use of suitable coordination instruments

Efficient coordination is characterised by the use of appropriate coordination instruments. Depending on their effect, coordination instruments are used firstly to reduce the coordination demand and secondly to cover the remaining coordination demand.[78] In this function they support and complement the activities of the coordinating actors in formal standards bodies during the implementation of the individual coordination tasks.
Systematisation of the instruments can take place as part of a classification into structural, technocratic, cultural, personnel and informational coordination.[79]

Structural coordination

The structural instruments of coordination include negotiation and agreement mechanisms, the establishment of a central coordination instance as well as supplementary decentralised coordination structures.
It is therefore necessary to determine the type of decision-making which is in keeping with the principles of standardisation, on the one hand, and efficient in terms of costs and time, on the other.
Also included in the field of structural coordination are the establishment of a central unit as a main coordination centre and the inclusion of voluntary coordinators as part of decentralised structures for projects and committees.

[77]For the motivational effect of accepted roles, cf. Welge 1975, 207.
[78]Hoffmann 1980, 328.
[79]Khandwalla 1975, 140ff. Further systematic approaches to coordination can be found in the surveys in Winkler 1999, 101ff and Corsten 2001b, 17f, Corsten/Reiß 1992, 40, Corsten 2001b, 19. For the interdependencies of coordination instruments, cf. Tröndle 1987, 122ff.

Coordination devices in standardisation

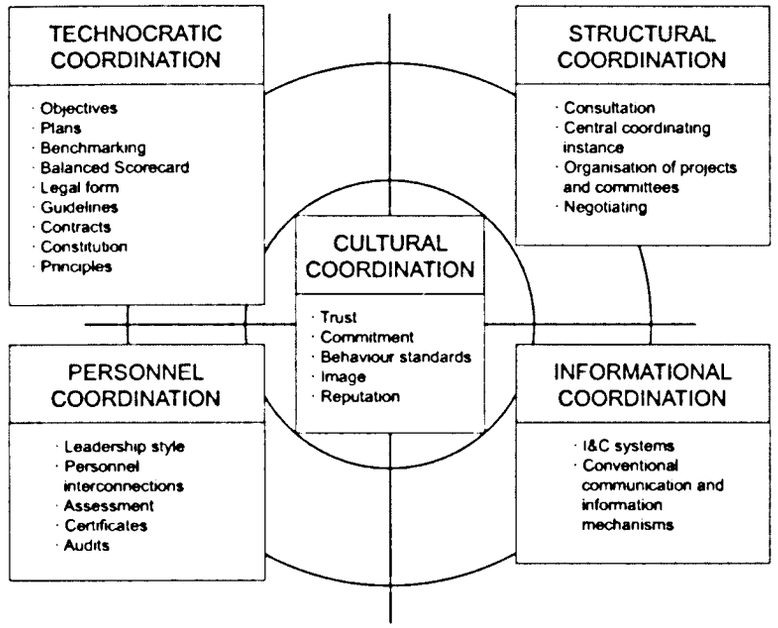


Figure: Coordination instruments in standardisation (Source: Riemer 2010)

Technocratic coordination

The technocratic coordination instruments include firstly the legal design, contracts, general terms and conditions of business, and extend to statutes and rules of procedure, guidelines and quality standards. Secondly, target agreements on key data, plans and programmes and their monitoring are employed for the economic control of network processes.
The legal form shapes the organisation of the management bodies and thus affects the forms in which political demands and objectives are formulated within the organisations.[80] Consequently, acknowledged standards bodies are primarily constituted as non-profit organisations, generally with the legal form of a registered association, as this appears to be particularly well suited to represent the basic democratic idea of standardisation.

[80]Bühner 1992, 206f.
[81]The tension exists both in the written stipulation and in the duration for which formalised rules and procedures are created and should be adapted to the particular matter that has to be regulated on a case-by-case basis (Samuel/Mannheim 1970, 216ff).

The documented codes and rules are often part of the field of conflict surrounding an appropriate level of formalisation, in other words: what is the correct proportion of formal guidelines in the network?[81] The use of organisational rules fixed in writing is not to be regarded as obstructive as long as the rules remain easily accessible and understandable for the standardisation actors. This particularly applies to rules that are subject to sanctions when breached.
The same applies to codes and rules based on business principles, consisting of objectives, plans and the monitoring thereof, e.g. through the use of a balanced scorecard. Applying this to standardisation, it is therefore possible to extend the information used in the evaluation beyond the established parameters, such as number of members, committees and standards, to include, for example, the beneficial positions of the partners from learning processes through contact with customers and competitors, increases in efficiency in standardisation work brought about through standardisation, the perception and evaluation of standardisation products by users, or the satisfaction of network participants and employees.

Cultural coordination
In addition to the formal codes and rules, control also takes place largely informally by means of culture-based coordination. Examples of suitable culturally based elements in standardisation are trust, commitment and behavioural norms as well as reputation and image. Hence the commitment of the interested parties to the responsibility community is the basis of existence for the standardisation community. The self-imposed commitment of the standardisation actors can, for example, be promoted by agreeing to certain codes of conduct and honour within the context of a psychological contract.
Reputation and image count as important resources during cultural coordination.[82] The high reputation of the acknowledged standards bodies thus contributes to the identification and recognition of standards. For a long time now, the DIN trademark has not been purely restricted to products complying with DIN standards. In the meantime, the DIN mark as a logo now also represents the quality of standardisation work and is present on all DIN publications.

Personnel coordination
Important potential for the infrastructure of standardisation lies in the integrative abilities and the willingness to integrate of the actors taking part.
The general shift from the roles of managers, from a decision-oriented role, to an interpersonal and informational role also affects the coordinators of standards.[83] It is not rare for a coordinator to have to act as a motivator in inducing the actors to produce the required contributions voluntarily.[84]

[82]Staber 2000, 70. Windeler 2001, 319.
[83]Walter/Teich 2002, 89.
[84]Koller et al. 2006, 58.

In this connection, a style of leadership focusing suitably on cooperation and willingness to achieve consensus is recommended for the performance of their management role, which tends to be based more on interpersonal than decision-making factors.
Furthermore, instruments of personnel coordination such as the integration of personnel in pools of experts or setting up an expertise database for the actors of standardisation are viewed as relevant in increasing the efficiency of coordination.

Informational coordination
Information and communication systems are particularly regarded as drivers of efficiency in standardisation.
Formal standards bodies are increasingly relying on electronic media in order to achieve the acceleration needed in the drafting of standards during the course of ever-shorter innovation cycles for new technologies, and to secure reductions in time and costs on the part of standards partners through more efficient standardisation processes.[85]
Similarly, the highly formalised standardisation process with the corresponding obligations to publish and provide information of the standardisation experts involved also demands electronic documentation of the standardisation work. Timetables, minutes and news are created and transferred for participants by means of electronic information and communication systems as part of the secretarial services. Various platforms (e.g. livelink operated by DIN) are already becoming established for these purposes. They act as information and filing systems and allow standardisation experts access to the information, such as for internal network publications or standard operating procedures.

5 Closing remarks

Despite their undisputed legitimising function, the existence of central coordinating standards bodies is not taken for granted.[86]
Actors try to alter institutions that do not match the requirements.[87] Here the influence of the actors involved within the context of their own interest is often underestimated.[88]
The constituting characteristics result in particular challenges for formal standards bodies in achieving efficient coordination.

[85]Cf. for example DIN 2004, 24ff.
[86]Winkler emphasises that despite the formal delegation by the network partners, the leadership and hence the potential influence of a central unit does not have to be permanently symbolised but reliably reproduced (Winkler 2002, 154). Cf. Section 3.2.3.2 on the expression 'taken for granted' within the context of institutional inertia.
[87]Mayntz/Scharpf 1995, 43ff.
[88]This applies especially to classical institutionalism (Sydow 1992, 209).

First of all, the barriers resulting from the externalities of public standards and the associated free-riding problem have to be overcome so that the expert knowledge of the interested parties can be mobilised. Due to the 'insti-tutional gap' identified in the standardisation network, an initiating instance is required that will motivate the interested parties to take part in standardisation thus making cooperation of the interested parties for the purpose of standardisation fundamentally possible.
Nevertheless, the challenge in harmonising the interests of all relevant groups of actors lies in motivating the interested parties with their heterogeneous different positions of interest, options and objectives, within the context of their trading conditions, to establish a consensus in keeping with the political interests. During the standardisation process, the actors are required to refrain from maximising their own benefits for the sake of the common good.
Although standards are inherently voluntary both in terms of their creation and their application, a certain degree of binding character is nevertheless required for them to develop their benefits.
In addition to the setting of standards, further aims of the standardisation network are therefore to disseminate standards and promote their application.

Efficient coordination of standardisation is based on the supply of needs-oriented coordination services. Apart from the coordination of tasks, consisting of strategy formulation, configuration of the value added, information and communication management as well as strategic controlling, standards bodies should focus a further part of their work on people coordination, namely regulation and sanctioning, constituting a network identity, public relations, partner development and conflict management.
When this broad range of coordination tasks is being implemented, the distribution should be largely based on skills. For this purpose, the skills dimensions of leadership skills, configuration skills, integration skills and change management skills can be used to draft role profiles with different focuses that can be allocated to the individual coordinators of the central unit.
The full-time professional coordinators of the standards bodies are supported in their activities by the use of structural, technocratic, cultural, personnel and informational coordination instruments.

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7 Glossary

Acknowledged standards body
So-called 'acknowledged' standards bodies are characterized by the fact that they are legitimised or furnished with a special status by the state, such as having the right to sole representation of their country in international standards bodies.

Balanced scorecard
Introduced in 1992 by Robert S. Kaplan and David P. Norton, the balanced scorecard (BSC) is a concept for documenting the results of measurements of a company's activities in terms of its vision and strategies, in order to offer the management personnel a comprehensive overview of the performance and ef-

fectiveness of the organisation. The new element is that the BSC does not focus on the finance perspective but also contains the human aspects that are the drivers for the results so that the organisation concentrates on its future and long-term interests.
Due to its flexible and hence comprehensive design options, the balanced scorecard is an instrument for establishing an integrated management system.
It is useful to define the measures of the BSC individually for each organisational unit. However, in practical terms they always include the perspectives of finance and customers, and usually the perspectives of process and potential or employees as well.
The key performance indicators in the BSC enable the development of this business version to be monitored. In this way, the BSC allows the management to not only consider the financial aspects but also control structural early indicators of the business success. (based on www.wikipedia.org)

Central unit
Specifically: the common and central coordinating instance of standardisation that has been commissioned by the standardisation actors to function as the centre of expertise and carry out the coordination of standardisation and is equipped with the appropriate powers of attorney.

Change management skills
Ability to diagnose, learn and manage conflicts; flexibility; dealing with uncertainty. (Source: Dissertation by Riemer)

Company standardisation
A company standard is a measure to introduce uniformity that is only valid for one particular enterprise (cf. Kleinemeyer 1997, p. 53).

Compatibility
Compatibility means the multiple use that can be made of a part or module in a variety of systems or standards. It is a decisive factor, for example, in the PC industry. Previously, it was better for PCs to be IBM-compatible so as to be able to work on the IBM standard.
(Source: Standardisation within Companies and Markets, Overall Glossary)

Configuration skills
Dimension of skill in the coordination of standards; includes organisation, business and functional segmentation, broad-based knowledge, internal and external accounting, legal know-how. (Source: Dissertation by Riemer)

Consortium/Forum
An industrial consortium is an organisation that does not normally generate public standards but is founded solely for the purpose of developing common

technical specifications for the use of its members, who frequently come from narrowly defined areas.
(CEN/BOSS Glossary: http://www.cenorm.be/BOSS/glossary.asp)

Consortial standards, consortia standards
These are normative deliverables, such as technical specifications or publicly available standards, that are cooperatively prepared in and published by standards consortia; they are to be distinguished from acknowledged or formal standards.

Coordination complexity
Approx. 80 per cent of all current standardization activities that take place in DIN today are directed towards the European and international level (DIN 2007a, 22, Eickhoff/Hartlieb 2002, 172). The decline in purely national standardisation projects is set to continue in favour of European and international standardisation projects, which will become increasingly important (DIN 1998a, 6f, Falke 2000, 9).

Coordination of standardisation/standardisation coordination
Coordination in the context of standardisation means matching the heterogeneous interests of the participating actors within the process of collectively reaching a consensus. Under this condition, the coordination function of the standards bodies is at the same time a necessary and undisputed prerequisite for the process of negotiation and establishing a consensus in standardisation.
Coordinating standardisation involves all those tasks required to shape the collaboration between the members throughout their entire cycle of cooperation. (Peitz 2002, 227, Otto 2002, 87)

Coordination task
Coordination is the matching and harmonising of decentralised decisions and actions by actors, with the aim of guiding the behaviour towards a common goal.

Cultural coordination
Examples of suitable culturally based elements in standardization are trust, commitment and behavioural norms as well as reputation and image. Hence the commitment of the interested parties to the responsibility community is the basis of existence for the standardisation community. (Source: Dissertation by Riemer)

De facto standard
De facto standards are standards that because they are so widespread on the market are implicitly binding for all companies. This is also referred to as 'de facto validity'. (David/Greenstein 1990, 4, Glanz 1993, 28)

Delegation principle
Regional and international standards bodies like CEN and ISO allow only national standards bodies such as DIN or BSI to become members (and do not permit direct representation of individual interests). Given this regime of indirect representation, the interested parties assemble under the aegis of their respective national standards bodies, form a common position on the shape that a regional or international standard should take and send a delegation to the respective regional/international standards body to explicate and negotiate this position.

Deutsches Institut für Normung e.V. (DIN)
The Deutsches Institut für Normung e.V. (DIN) was founded in 1917 under the name of Normalienausschuss für den allgemeinen Maschinenbau and is the national standards body for the Federal Republic of Germany. DIN is a registered engineering and scientific association with its own legal personality and operates on a non-profit basis. The task of DIN and its subsidiaries is to create technical regulations with assistance from all interested parties (companies, organised interest groups, the state) on the basis of consensus and transparency and to promote their application. (Source: Standardisation within Companies and Markets, Overall Glossary)

Externality
Externalities arise because the goods produced by pooling resources cannot be restricted to those making contributions. Participation in the collective action thus has a (positive) externality for the so-called free riders.
(Riemer)

Fast-track procedure
With their so-called fast-track procedure the standards bodies are reacting to the growing criticism of their working methods. However, as both the delegation principle and the public appeals procedure are omitted in order to achieve a swifter procedure, the new standardisation concepts differ fundamentally from the 'traditional' processes of acknowledged standards bodies. Consequently, the specifications thus obtained are also not able to claim the legitimised status of an acknowledged standard.

Formal standardisation
Formal standardisation is the creation of a system of conformity for tangible and intangible objects through the participation of all interested groups. Aims of formal standardisation may include the reduction of variety, increasing fitness for purpose, compatibility and interchangeability. (Source: Standardisation within Companies and Markets, Overall Glossary)

Group of actors
Group of persons with similar interests who convene in order to develop standards. This may take the form of: companies of all sizes from all industries, consumers, users and employees, who are directly affected by the standardisation; associations and representatives of companies, consumers and employers, such as trade unions, chambers of commerce and industry; the scientific community, meaning universities or research institutes, organisations involved in the field of accreditation and certification; national, regional and international standards bodies.

Industry standard
An industry standard is an engineering standard which during the course of years of practical application by many users and various manufacturers has proven to be technically beneficial and correct in adhering to a certain pragmatic body of rules. An (inter)national standardisation procedure has, however, not been conducted. (Based on www.wikipedia.org)

Informational coordination
Timetables, minutes and news are created and transferred for participants by means of electronic information and communication systems as part of the secretarial services. Various platforms (e.g. livelink operated by DIN) are already becoming established for these purposes which act as information and filing systems and allow standardisation experts access to the information, such as for internal network publications or standard operating procedures. (Source: Dissertation by Riemer)

Instrument of coordination
Efficient coordination is characterised by the use of appropriate coordination instruments. Depending on their effect, coordination instruments are used firstly to reduce the coordination demand and secondly to cover the remaining coordination demand. In this function they support and complement the activities of the coordinating actors in standards bodies during the implementation of the individual coordination tasks. Systematisation of the instruments can take place as part of a classification into structural, technocratic, cultural, personnel and informational coordination.
(Khandwall 1975, 140 ff)

Integration skills
Dimension of skill in the coordination of standards; includes handling negotiations, solving conflicts, building confidence, ability in information and communication, the ability to enter into a dialogue, lecturing and presentation skills, selection of information, creation of transparency, feedback and conflict management ability, ability to adapt, work in a team and persuade, infrastructural skill, IT skills. (Source: Dissertation by Riemer)

Interested parties
The interested parties can be classified into the following groups of actors: companies of all sizes from all industries, consumers, users and employees, who are directly affected by the standardisation; associations and representatives of companies, consumers and employers, such as trade unions, chambers of commerce and industry; the scientific community, meaning universities or research institutes, organisations involved in the field of accreditation and certification; national, regional and international standards bodies.

Leadership skills
Dimension of skill in the coordination of standards; includes the abilities to initiate, set targets, solve problems, delegate responsibility, develop personnel as well as presentation and mediation skills, commercial skills, safeguarding skills, marketing, recruiting and promotional skills. (Source: Dissertation by Riemer)

People coordination (coordination of persons)
People coordination is relationship management, which is directed towards current or potential network participants. Within the context of member coordination, the standards bodies are responsible for the task of regulating and sanctioning, constituting a network identity, public relations and partner development as well as conflict management.

Mirror committee
During supranational and international standardisation, participation in the standardisation process consists of direct participation in the mirror committees of the national standards bodies. In voting on supranational or international standards, these national delegations can only appear in a united form. The mirror committee is responsible for working on the written documents, appointing the national delegation, supplying a version in the national language and casting the national vote on drafts. This committees also have to make sure that the broad-based specialised public within its country is summoned to give an opinion in time. (Falke 2000, 201)

Network effects
Network effects occur when the utility of an individual network participant depends on the size of a network (the total number of network participants). Network effects may be positive (individual utility increases with growing size of a network - the case usually discussed in the literature) or negative (individual utility decreases with growing size of a network).

Non-excludability
Non-excludability describes a situation when it is not possible to prevent people who have not paid for a good or service from having access to it. Together with

non-rivalry, it is a characteristic attribute of a public good.
(Based on http://en.wikipedia.org)

Non-rivalry
One agent's consumption of a good has no (adverse) effect on other agents' consumption of that good. Together with non-excludability, non-rivalry forms the characteristic attribute of a public good.

OECD
Organisation for Economic Co-operation and Development. The OECD is a group of 30 countries sharing a commitment to democratic government and the market economy. Having active relationships with some 70 other countries, NGOs and civil society, it has a global reach. Best known for its publications and its statistics, its work covers economic and social issues from macroeconomics, to trade, education, development and science and innovation.
(http://www.oecd.org/about/0,2337,en_2649_201185_1_1_1_1_1,00.html)

Personnel coordination
The general shift of the roles of managers from a decision-oriented role to an interpersonal and informational role also affects the coordinators of standards. It is not rare for a coordinator to have to act as a motivator in inducing the actors to produce the required contributions voluntarily. In this connection, a style of leadership focusing suitably on cooperation and willingness to achieve consensus is recommended for the performance of their management role, which tends to be based more on interpersonal than decision-making factors.
(Source: Dissertation by Riemer)

Product life cycle
The product life cycle visualises and sums all the costs, sales and revenues that a product incurs from its creation up until its degeneration and entry into the recycling process. As a result, every product can be easily classified into a company's portfolio matrix.
(Source: Standardisation within Companies and Markets, Overall Glossary)

Project management
Projects are distinguished by their one-off nature, novelty and complexity. A clearly specified objective is pursued by means of a clearly defined task. There are limited resources and fixed budget with a defined point in time for the beginning and end. Project management is the entirety of tasks, organisation, techniques and resources involved in managing a project. (Based on www.wikipedia.org)

Standard
According to EN 45020 a standard is a 'document, established by consensus and approved by a recognized body, that provides, for common and repeated use,

rules, guidelines or characteristics for activities or their results, aimed at the achievement of the optimum degree of order in a given context.'
(Source: Standardisation within Companies and Markets, Overall Glossary)

Standardisation
Standardisation is understood to mean a collective process of unification for solving a problem (cf. Kleinemeyer 1996, 27). Standardisation describes in general the 'approximation and unification of materials or also processes for the benefit of those involved' (cf. Loew von und zu Steinfurth 1986, 879ff).

Standardisation actors
Standards are not created within a public authority but in collaboration with a large number of different actors, known as the interested parties. During a consensus-based standardisation process, these parties take part cooperatively and with equal negotiating rights as regards the necessity for and the contents of a standard. (Source: Standardisation within Companies and Markets, Overall Glossary)

Standards committee
A standards committee in DIN is responsible for national standardisation and represents German standardisation interests at European level (European Committee for Standardization, CEN) in the CENT/TC (technical committee) and at the international level in ISO. (Source: Standardisation within Companies and Markets, Overall Glossary)

State of the art, acknowledged rules of technology
State of the art denotes the best possible solution to a problem at a given point in time and a given state of scientific knowledge. A basic principle of standards preparation is usually to adhere to the state of the art.

Stewards
External specialised coordination offices that take on a function of controlling and legitimising in complex organisational structures, because the demands on the latter are too high for them to develop 'natural' management positions on their own due to the close economic relations of competition and exchange as well as the dynamics of development.

Structural coordination
The structural instruments of coordination include negotiation and agreement mechanisms, the establishment of a central coordination instance as well as supplementary decentralised coordination structures. It is therefore necessary to determine the type of decision-making which is in keeping with the principles of standardisation, on the one hand, and is efficient in terms of costs and time on the other. Also included in the field of structural coordination are the establishment of a central unit as a main coordination centre and the inclusion

of voluntary coordinators as part of decentralised structures for projects and committees. (Source: Dissertation by Riemer)

Task coordination
At the centre of task coordination are the performing processes of a network. Task coordination involves items such as strategy formulation, value-added coordination, information and communication management as well as strategic controlling.

Taylorism
Taylorism or scientific management dates back to the American Frederick Winslow Taylor. Taylor believed that management, labour and enterprise could be optimised with a purely academic approach (scientific management) and thus social problems could be solved and 'prosperity for all' achieved.
(Source: http://www.arbeitslehre.de/wiki/Taylorismus)

Technocratic coordination
The technocratic coordination instruments include firstly the legal design, contracts, general terms and conditions of business and extend to statutes and rules of procedure, guidelines and quality standards. Secondly, target agreements on key data, plans and programmes and their monitoring are employed for the economic control of network processes.
(Source: Dissertation by Riemer)

8 Key questions

- How does formal standardisation differ from standardisation in consortia? Name groups of actors who contribute to the typical heterogeneity of interests in standardisation.
- What requirements are made of the coordinating standards body? Name two fields each for the coordination of functions and members in standards bodies.
- Which skills are necessary to perform these tasks?

Mingshun Song · Hui Jiang · Hongkuan Wu

Abstract

This lecture deals with international standardization, which includes international organizations for standardization, the activities of these organizations, participation in international standardization and the influence of international standards on trade policies. With the development of globalization and integration of the world economy, it is imperative that not only governments but also companies create relevant international standards in order to broaden lines of business, strengthen cooperation and provide convenience for business. This unit will be helpful in understanding the basic concepts of international standardization. Chapter 1 introduces the basic principle and the main purpose of standardization. Chapter 2 provides an introduction to several key formal international organizations for standardization while Chapter 3 introduces several informal international organizations for standardization. Then, in Chapter 4, participation in international standardization is addressed. Chapter 5 describes the influence of international standards on trade policies. Concluding remarks are made in Chapter 6.

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1 Preface

International standardization is the activity of establishing and recording a limited set of solutions to actual or potential matching problems, directed at benefiting the party or parties involved, balancing their needs, and intending and expecting that these solutions will be repeatedly or continuously used during a certain period and by a substantial number of the parties for whom they are meant. Some international organizations and institutes, such as ITU, IEC and ISO, draft these standards. The main goals of drafting and implementing international standards are as follows: to facilitate technology transfer, broaden the line of business in the global market, strengthen cooperation among trading countries and companies, and improve the quality and safety of products. In other words, international standardization standardizes the production and sale of products in different countries, regions, companies and markets. In order to implement international standardization, international organizations or institutes for standardization have drafted many international standards and rules. Nevertheless, there are also many problems in the field of international standardization. The basic political questions concerning international standardization are whether or not international standardization facilitates world trade and whether or not developed countries play a key role in the creation of international standards. Readers of this lecture will learn that differences in economic development and conflicting opinions among different countries obstruct the development and implementation of international standardization although great achievements have been made in recent years. A short remark on the references completes this lecture. The authors have relied on Internet resources because this approach provides the most up-to-date snapshot of present international standardization. Those readers who are interested in international standardization may visit the 'References' section for more details.
See: www.wto.org

2 Introduction to formal international organizations for standardization

2.1 International Telecommunication Union (ITU)

2.1.1 History

On 24 May 1844, Samuel Morse sent his first public message over a telegraph line between Washington and Baltimore. That simple act ushered in the telecommunications age and many countries began to sign bilateral or regional agreements. By 1864, several regional conventions had been made. On 17 May 1865, after two and a half months of arduous negotiation, the first International Telegraph Convention was signed in Paris by the 20 founding members, and the International Telegraph Union (ITU) was established to facilitate subsequent amendments to this initial agreement. In 1947, after the Second World War, ITU held a conference in Atlantic City with the aim of developing and modernizing the organization. Under an agreement with the newly created United Nations, ITU became a UN specialized agency on 15 October 1947. The headquarters of the organization was transferred from Bern to Geneva in 1948. The main purposes of ITU are as follows:

- To maintain and extend international cooperation between all member states for the improvement and rational use of telecommunications of all kinds.
- To promote and enhance participation of entities and organizations in the activities of the Union.
- To promote and offer technical assistance to developing countries in the field of telecommunications.
- To promote the development and most efficient operation of technical facilities.

2.1.2 Organization

After reorganization, the Union was streamlined into three sectors, corresponding to three main areas of activity. The three sectors included: Telecommunication Standardization (ITU-T), Radio Communication (ITU-R) and Telecommunication Development (ITU-D). As of August 2005, ITU had 189 member states and 637 Sector Members (308 ITU-D, 303 ITU-R, 353 ITU-T). ITU-R coordinates radio communication services, radio-frequency spectrum management and wireless services. ITU-D focuses on technical assistance in the development of telecommunication networks and services to developing countries and countries with economies in transition. ITU-T ensures the efficient and timely production of high-quality standards covering all fields of telecommunications on a worldwide basis, as well as defining tariff and accounting principles for international telecommunication services.

ITU General Secretariat
The General Secretariat manages the administrative and financial aspects of the Union's activities, including the provision of conference services, information services, long-range strategic planning, and corporate functions (communications, legal advice, finance, personnel and common services). The following figure illustrates the ITU General Secretariat structure.
See: www.ITU.int (ITU General Secretariat structure)

ITU Plenipotentiary Conference
The Plenipotentiary Conference is the top policy-making body of the International Telecommunication Union. Held every four years, the Conference sets the Union's general policies, adopts five-year strategic and financial plans and elects the senior management team of the organization. The conference is the key event for all ITU Member States to decide on the future role of the organization.

ITU Council:
The role of the Council is to consider, in the interval between Plenipotentiary Conferences, broad telecommunications policy issues to ensure that the Union's activities, policies and strategies fully respond to today's dynamic, rapidly changing telecommunications environment. It also prepares a report on ITU policy and strategic planning. In addition, the Council is responsible for ensuring the smooth day-to-day running of the Union, coordinating work programmes, approving budgets and controlling finances and expenditure. The following figure illustrates the ITU administrative entities structure.
See: www.itu.int (ITU administrative entities structure)

2.1.3 Administrative entities of ITU-T

ITU-T World Telecommunication Standardization Assembly (WTSA) sets the overall direction and structure for ITU-T and meets every four years. It defines the general policy for the sector, establishes the study groups, approves their expected work programmes for the next four-year period, and appoints their chairmen and vice-chairmen. ITU-T Telecommunication Standardization Advisory Group (TSAG) provides ITU-T with flexibility between WTSAs, and reviews priorities, programmes, operations, financial matters and strategies for the sector. It also follows up on the accomplishment of the work programmes, restructures and establishes ITU-T study groups, provides guidelines to the study groups, advises the Director of the Telecommunication Standardization Bureau (TSB), and produces the A-series Recommendations on organization and working procedures.

ITU-T overview
ITU-T stands for the International Telecommunication Union - Telecommunication Standardization Sector. It acts as a platform for governments and the private sector to coordinate the development of international standards for global telecommunication networks and services.

Mission
The ITU-T mission is to ensure the efficient and on-time production of high-quality standards covering all fields of telecommunications on a worldwide basis, as well as defining tariff and accounting principles for international telecommunication services.

Achievements
As of March 2005, there were approximately 3,100 recommendations in force on topics ranging from service definition to network architecture and security. Other topics include dial-up modems to Gbit/s optical transmission systems, next-generation networks (NGN) and IP-related issues. The relative ease of communicating by phone, computers or fax across the globe is a direct result of the work of ITU-T.

Aims and ambitions
ITU-T aims to retain its position as the pre-eminent worldwide telecommunications standards body. In recognition of the rapidly changing information and communication technologies (ICT) environment, ITU-T continues to adapt its procedures and practices to ensure that it can respond quickly to the demands of the industry. The Alternative Approval Process (AAP), introduced in 2000, has been a tremendous success, with the majority of new recommendations being approved within six weeks of submission.

Current work areas
ITU-T is now addressing the international standards requirements for the 21st century in areas such as:
- Next-generation networks (NGN)
- Broadband access
- Multimedia services
- Emergency telecommunications
- IP issues
- Optical networking
- Network management
- Internet governance
- ICT security issues
- Fixed/mobile convergence

Products
The main products of ITU-T are normative recommendations. These are divided into themed series, i.e., the G-series covers recommendations on 'Transmission systems and media, digital systems and networks', and the H-series covers 'Audiovisual and multimedia systems'. Recommendations can be amended with additions or corrections that could become annexes, amendments or corrigenda, depending on the nature and content of the changes.

Non-normative
Non-normative outputs include appendices to recommendations, ITU-T handbooks, and implementer's guides and supplements. Another ITU-T product is the Operational Bulletin, published fortnightly, which is a detailed update containing information that is required to maintain the global interconnection of the world's telecommunication networks.
Currently, there are 22 study groups spanning the Union's three Sectors (7 in ITU-R, 13 in ITU-T, 2 in ITU-D), which produce around 550 new or revised recommendations every year. All ITU recommendations are non-binding, voluntary agreements. Each sector also has its own bureau, which ensures the implementation of the sector's work plan and coordinates activities on a day-to-day basis.

2.2 International Electrotechnical Commission (IEC)

2.2.1 History

The IEC was officially founded in June 1906, in London, England, where its Central Office was set up. By 1914, the IEC had formed four technical committees to deal with Nomenclature, Symbols, Rating of Electrical Machinery, and Prime Movers. The First World War interrupted IEC work, which resumed in 1919, and by 1923, the number of technical committees had increased to 10. In 1938, the IEC produced the first edition of the International Electrotechnical Vocabulary (IEV). In 1948, the IEC Central Office moved from London to Geneva, Switzerland. From 1948 to 1980, the number of technical committees grew from 34 to 80. In 1974, the IEC created Technical Committee 76, to address standards relating to lasers, with a particular focus on safety. In 1995, the IEC set up the Lord Kelvin Award. In 2001, the Commission published the most recent edition of the IEC Multilingual Dictionary. The IEC is the leading global organization that prepares and publishes international standards for all electrical, electronic and related technologies. IEC's objectives are:
- To meet the requirements of the global market efficiently.
- To ensure primacy and maximum worldwide use of its standards and conformity assessment schemes.

- To assess and improve the quality of products and services covered by its standards.

2.2.2 Organization

The supreme authority of the IEC is the Council, which is the general assembly of the National Committees consisting of the Commission's members. The IEC also comprises management, executive and advisory bodies and Officers. The Officers of IEC are the President, Deputy President (Immediate Past-President or President-elect), Vice-Presidents, Treasurer, and General Secretary.
See: www.iec.ch (the structure of IEC).
The management of IEC is very complex. Several committees and boards are in charge of a wide range of tasks.

Committees
The management advisory committees of IEC include: President's Advisory Committee on Future Technology (PACT), Marketing Committee, Sales Policy Committee and Finance Committee.

Boards
Standardization Management Board
The Standardization Management Board (SMB) is responsible for the management of IEC standards work including the creation, dissolution and scope of IEC technical committees, the timeliness of standards production and liaisons with other international organizations.

Conformity Assessment Board
The Conformity Assessment Board (CAB) is responsible for the overall management of IEC conformity assessment activities. The CAB is a decision-making body that comprises the Chairman, 12 voting members (and alternates) elected by Council, one representative from each IEC conformity assessment scheme, IEC Treasurer and General Secretary. It reports all its decisions to the Council Board.

2.2.3 Who produces the standards?

IEC standards are international standards adopted by the World Trade Organization's Agreement on Technical Barriers to Trade (TBT). Some 179 technical committees (TCs) and subcommittees (SCs), and about 700 project/maintenance teams carry out the standards work of the IEC. These working groups are composed of people from all around the world who are experts in electrotechnology. Each National Committee of the IEC handles the participation of experts from its own country. Most experts come from industry, while other

contributors come from commerce, government, test laboratories, research laboratories, academia and consumer groups.
The technical committees prepare technical documents on specific subjects within their respective scopes, which are then submitted to the Full Member National Committees (IEC members) for voting with a view to their approval as international standards. In all, some 10,000 experts worldwide participate in the technical work of IEC. Distribution of documents for standards production is 100% electronic, thus improving efficiency and reducing costs.

2.2.4 The categories of IEC

The IEC produces two categories of publications: international consensus products and limited consensus products.

International consensus products
International consensus products include International Standards (IS, full consensus), Technical Specifications (TS, full consensus not yet reached), Technical Reports (TR, information different from an IS or TS), Publicly Available Specifications (PAS), and Guides (non-normative publications).
Technical Specification: similar to an IS in that it is normative in nature, developed according to consensus procedures and approved by two-thirds of the Participating Members of an IEC technical committee or subcommittee. A TS is published when required support for an IS cannot be obtained, when the subject is still under technical development, or when there is a future for - but no immediate possibility of - an IS.
Technical Report: more descriptive than normative, this is an informative document of a different kind to normative documents (e.g. collection of data). A TR is approved by a simple majority of Participating Members of an IEC technical committee or subcommittee. Publicly Available Specification: a normative document that represents a consensus among experts. A simple majority of the Participating Members of a technical committee or subcommittee approves the document. An IEC-PAS responds to an urgent market need for such a normative document and is designed to bring the work of industry consortia into the realm of IEC. Guide: deals with non-normative matters related to international standardization. An example is the application of 'horizontal' standards.

Limited consensus products
Limited consensus products include the Industry Technical Agreement (ITA) and Technology Trend Assessment (TTA). Industry Technical Agreement: a normative or informative document that specifies the parameters of a new product or service. It is developed outside the technical structures of the IEC and it helps to enable the production and/or market launch of industry products to proceed. It is similar to an industrial de facto standard or specification. Fast-moving technology sectors are the main potential users of ITAs, but the whole

domain of electrical and electronic engineering (including ICT) may be covered. Technology Trend Assessment: highlights certain aspects of a technology that might conceivably become an area for standardization in the near-to-medium term. It responds to the need for global collaboration on standardization questions during the early stages of technical innovation. A TTA describes the state of the art or trend in emerging fields. It is typically the result of pre-standardization work or research.

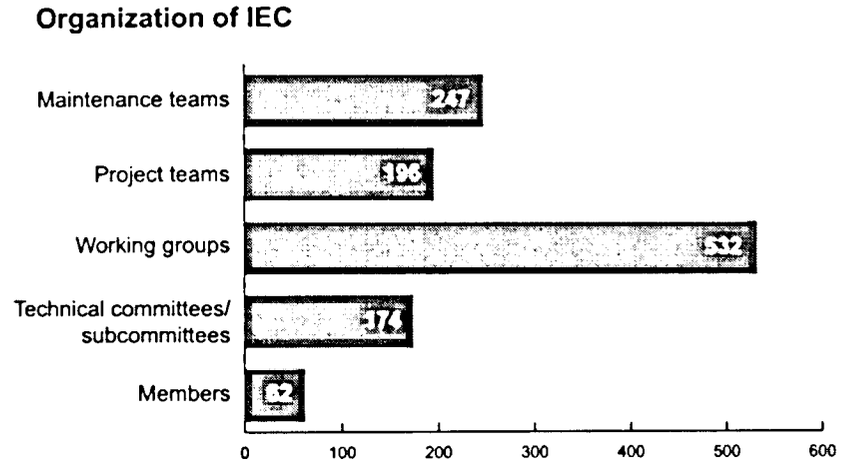


Figure: Organizations of IEC (© Song)

2.3 International Organization for Standardization (ISO)

2.3.1 History

Standards and ISO
Standards make an enormous contribution to most aspects of our lives although very often that contribution is invisible. We are usually unaware of the role played by standards in raising levels of quality, safety, reliability, efficiency and interchangeability as well as in providing such benefits at an economical cost.
The International Organization for Standardization (ISO) is the world's largest developer of standards. Although ISO's principal activity is the development of technical standards, ISO standards also have important economic and social repercussions. ISO standards make a positive difference, not just to engineers and manufacturers for whom they solve basic problems in production and distribution, but to society as a whole.

The publications of IEC

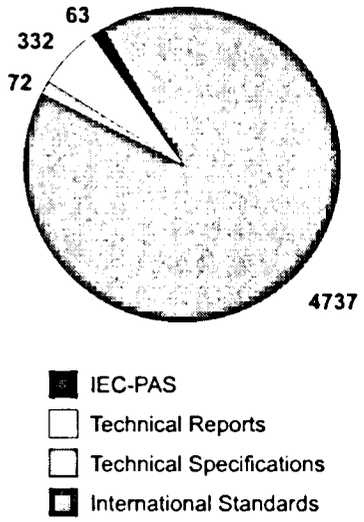


Figure: Publications of IEC (© Song)

What is ISO?
ISO is a network of the national standards institutes of 146 countries, on the basis of one member per country, with a Central Secretariat in Geneva, Switzerland. ISO is a non-governmental organization; its members are not delegations of national governments. International standardization began in the electrotechnical field. In 1946, delegates from 25 countries met in London and decided to create a new international organization, the object of which would be 'to facilitate the international coordination and unification of industrial standards'. The new organization, ISO, officially began operations on 23 February 1947.

ISO international standards
The international standards that ISO develops are very useful to industrial and business organizations of all types, to governments and other regulatory bodies, to trade officials, to conformity assessment professionals, to suppliers and customers of products and services in both public and private sectors, and, ultimately, to people in general in their roles as consumers and end users. ISO benefits all of society. The widespread adoption of international standards means that suppliers can produce their products and services based on widely accepted, unified specifications. This, in turn, means that businesses using international standards are increasingly free to compete in many more markets around the world. Since 1947, ISO has published more than 13,700 international

standards. ISO's work programmes range from standards for traditional activities such as agriculture and construction, through mechanical engineering, to medical devices and the latest information technology developments, such as digital coding of audio-visual signals for multimedia applications.

The logo of ISO



Figure: The logo of ISO (Source: www.iso.org)

2.3.2 Organization

ISO management
All strategic decisions are referred to ISO members, who meet for an annual General Assembly. Members review proposals developed by the ISO Council, which resembles the board of directors of a business organization, with members drawn from the membership as a whole. The ISO Council meets three times a year, and its members are rotated to ensure that it is representative of ISO's membership. Operations are managed by the Secretary-General, whose appointment is permanent. The Secretary-General reports to the President, who is a prominent figure in standardization or in business and is elected for two years. The Secretary-General is based at the ISO Central Secretariat in Geneva, Switzerland, with a compact staff, which provides administrative and technical support to ISO members, coordinates the decentralized standards' development programme, and publishes the output.

Member categories of ISO
Membership in ISO is open to national standards institutes or similar organizations that are most representative of standardization in their country (one

member in each country). ISO members are divided into three categories: Member bodies, Correspondent members and Subscriber members.

- Member bodies: A member body of ISO, known as 'full member', is the national body 'most representative of standardization in its country'. Only one full member for each country is accepted for membership in the ISO. Member bodies are entitled to participate and exercise full voting rights on any technical committee or policy committee of ISO.
- Correspondent members: A correspondent member is usually an organization in a country that does not yet have fully developed national standards activities. Correspondent members do not take an active part in the technical and policy development work, but are entitled to be kept fully informed about the work of interest to them.
- Subscriber members: Subscriber membership has been established for countries with very small economies. Subscriber members pay reduced membership fees that nevertheless allow them to maintain contact with international standardization activities.

See: www.iso.org (ISO Structure)

2.3.3 ISO mechanism for international standards

How ISO decides what standards to develop

If an industry or business sector needs a new standard, it should communicate the requirement to one of ISO's national members. The member then proposes the new work item to ISO. If accepted, the work item is assigned to an existing technical committee. Proposals may also be made to set up technical committees to cover new scopes of technological activity. In order to use resources most efficiently, ISO only launches the development of new standards for which there is clearly a market requirement.

Who develops ISO standards

ISO standards are developed by technical committees (TC), subcommittees (SC), working groups (WG) and study groups (SG). These groups are comprised of experts on loan from industrial, technical and business sectors who have requested the standards, and will subsequently put them to use. The experts may be joined by others with relevant knowledge, such as representatives of government agencies, testing laboratories, consumer associations, environmentalists, etc. The experts participate as national delegations, chosen by the ISO national member institute for the country concerned.

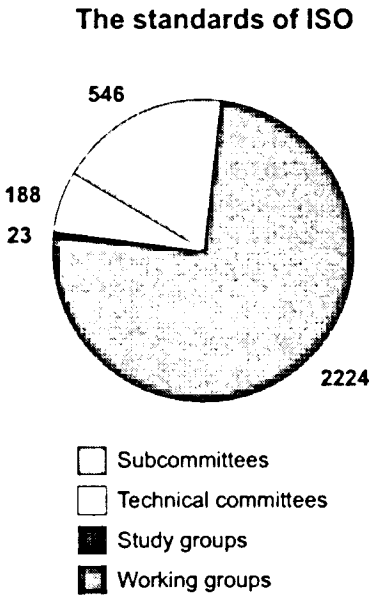


Figure: The standards of ISO (© Song)

How ISO standards are developed

The national delegations of experts of a technical committee meet to discuss and debate until they reach consensus on a draft agreement. This is then circulated as a Draft International Standard (DIS) to ISO's membership as a whole for comment and balloting. Many members have public review procedures for making draft standards known and available to interested parties and to the general public. The ISO members then take account of any feedback they receive in formulating their position on the draft standard. If the voting is in favour of the draft, the document, with eventual modifications, is circulated to the ISO members as a Final Draft International Standard (FDIS). If that vote is positive, the document is then published as an International Standard.

The procedure of making ISO Standards

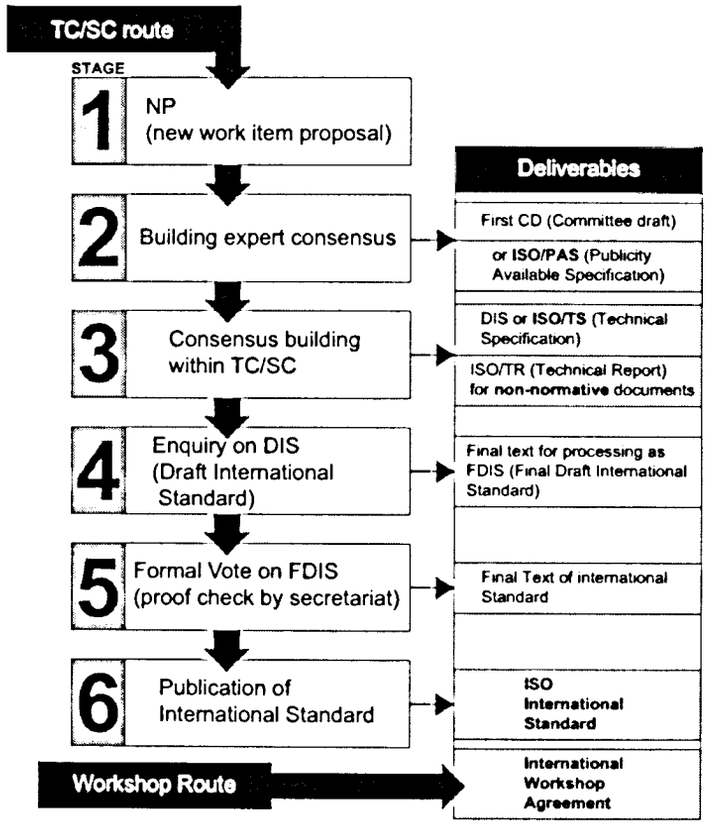


Figure: The procedure of making ISO standards (© Song)

2.3.4 The characteristics of ISO standards

The key criteria for ISO standards are that they should be equal, voluntary, market-driven, consensual and international.

Equal footing
Every participating ISO member institution has the right to take part in the development of any standard which is judged to be important to its country's economy. No matter what the size or strength of that economy, each participating member in ISO has one vote.
ISO activities are thus carried out in a democratic framework where each country has an equal influence on the direction of ISO's work at the strategic level, as well as on the technical content of its individual standards.

Voluntary
ISO standards are voluntary. As a non-governmental organization, ISO has no legal authority to enforce their implementation. Some ISO standards - those mainly concerned with health, safety or environment - have been adopted in some countries as part of their regulatory framework, or are referred to as the technical basis for legislation. Using ISO standards is a sovereign decision made by the regulatory authorities or governments of the countries concerned; ISO itself does not regulate or legislate. However, although ISO standards are voluntary, they may become a market requirement, as has happened in the case of ISO 9000 quality management systems or of dimensions of freight containers and bank cards.

Market-driven
ISO develops only those standards for which there is a market requirement. The work is carried out by experts on loan from the industrial, technical and business sectors which have asked for the standards, and subsequently put them to use.

Consensual
Although ISO standards are voluntary, the fact that they are developed in response to market demand and are based on consensus among the interested parties ensures widespread applicability of the standards. ISO takes account of both evolving technology and evolving interests by requiring a review of its standards at least every five years to decide whether they should be maintained, updated or withdrawn. In this way, ISO standards retain their position as state of the art, as agreed by an international cross-section of experts in the field.

International
ISO standards are technical agreements that provide the framework for compatible technology worldwide. Developing technical consensus on this international

scale is a major operation. In all, there are more than 2,850 ISO technical groups (technical committees, subcommittees, working groups, etc.) in which some 30,000 experts participate annually to develop ISO standards.

2.3.5 ISO 9000 and ISO 14000 as examples of well-known standards

The ISO 9000 and ISO 14000 families are among ISO's most widely known and successful standards. ISO 9000 has become an international reference for quality requirements in business-to-business dealings, and ISO 14000 looks set to achieve at least as much, if not more, in helping organizations to meet their environmental challenges. ISO 9000 is concerned with 'quality management', which is defined as what an organization does to enhance customer satisfaction by meeting customer and applicable regulatory requirements and how it continues to improve its performance in this regard. ISO 14000 is primarily concerned with 'environmental management', which is defined as what an organization does to minimize harmful effects on the environment caused by its activities and how it continues to improve its environmental performance.

3 Informal organizations for standardization

3.1 The Institute for Electrical and Electronics Engineers (IEEE)

3.1.1 History

The IEEE dates back to 1884, when its predecessors, the American Institute of Electrical Engineers (AIEE) and later the Institute of Radio Engineers (IRE), were founded by electrical engineering innovators who understood the value of shared information. The IEEE vision is to advance global prosperity by fostering technological innovation, enabling members' careers, and promoting community worldwide. The IEEE is the world's largest technical professional association, connecting more than 360,000 members in approximately 150 countries. Through its members, IEEE is a leading authority in technical areas ranging from computer engineering, biomedical technology and telecommunications to electric power, aerospace and consumer electronics.

3.1.2 IEEE Standards Association

The Institute of Electrical and Electronics Engineers Standards Association (IEEE-SA) is the leading developer of global industry standards in a broad range of industries, which include power and energy, biomedical and healthcare, information technology, telecommunications, transportation, nanotechnology and information assurance.
See: www.ieee.utwente.nl (the structure of IEEE)

3.2 American Society for Testing and Materials (ASTM)

3.2.1 History

ASTM is one of the largest voluntary standards development organizations in the world and an important source of technical standards for materials, products, systems and services.
ASTM, originally known as the American Society for Testing and Materials (ASTM), was formed over a century ago. Today, ASTM plays a leadership role in addressing the standardization needs of global markets. Standards developed by ASTM are the work of over 30,000 ASTM members. ASTM offers four different types of membership: informational membership, participating membership, organizational membership and student membership. ASTM technical committees are made up of professionals from around the globe who develop ASTM standards. There are over 130 ASTM technical committees covering diverse industry areas ranging from metals to environment.

3.2.2 Strategic objective

The strategic objectives of ASTM are as follows:
- To provide the optimum environment and support for technical committees to develop standards and related information;
- To ensure that ASTM products and services are provided in a timely manner and meet current needs;
- To increase the awareness of the ASTM consensus process, the benefits of participation, and the value of ASTM standards and services in the global marketplace;
- To strengthen both the national and international acceptance and use of ASTM products and services;
- To make ASTM processes, resources, skills, and facilities available to the marketplace to accommodate its changing needs.

See: www.astm.org

3.3 Internet Engineering Task Force (IETF)

3.3.1 Introduction

IETF is a large international community of network designers, operators, vendors, and researchers concerned with the evolution of Internet architecture and the smooth operation of the Internet. It is open to any interested individual, and much of the task force work is handled via mailing lists. The IETF holds meetings three times per year.

3.3.2 The Internet standards and process

Generally speaking, an Internet standard is a specification that is stable and well understood, is technically competent, has multiple independent and interoperable implementations based on substantial operational experience, enjoys significant public support, and is recognizably useful on some or all parts of the Internet. The process of creating an Internet standard is straightforward and consists of an initial proposal, creating a draft of the standard, and IESG review, approval and final publication.

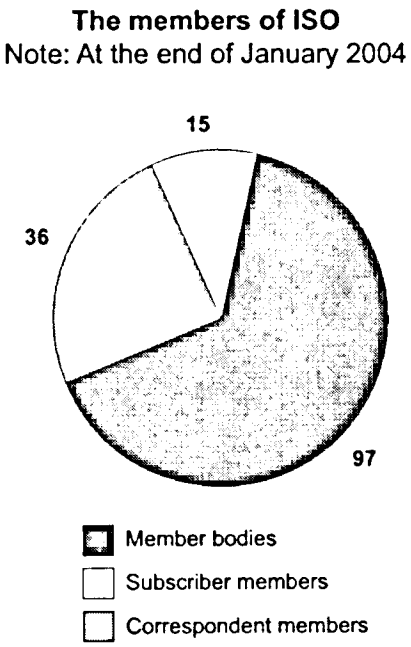


Figure: The members of ISO (© Song)

4 Participation in international standardization

ISO and IEC are given as examples of introducing participation in international standardization.

4.1 Members of international standardization organizations

Only ISO and IEC members can take part in international standardization activities.

4.1.1 ISO members

Membership of ISO is open to national standards institutes or similar organizations that are most representative of standardization in their country (one member in each country). Full members, known as 'Member bodies', each have one vote, whatever the size or strength of the economy of the country concerned.

4.1.2 IEC members

An IEC member is called a National Committee (NC), and each NC represents its nation's electrotechnical interests in IEC management and standardization work.

This includes:
- Manufacturers, providers, distributors and vendors, consumers;
- All levels of government agencies;
- Professional societies and trade associations;
- Standards developers.

4.1.3 Who are the presidents of ISO and IEC?

The presidents and vice-presidents of ISO and IEC are responsible for managing ISO and IEC activities on standardization. Most of the presidents and vice-presidents come from developed countries such as the US and EU member nations.

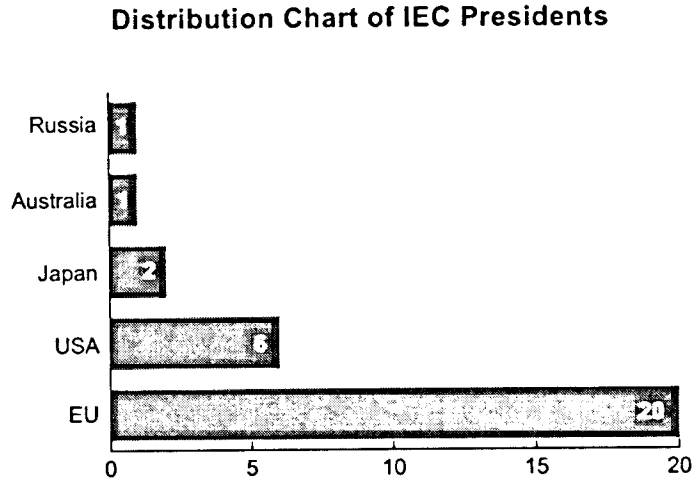


Figure: Distribution chart of IEC presidents (© Song)

4.2 Who plays a key role in the creation of international standards?

International standards are developed by TCs, SCs, WGs and SGs, comprising experts on loan from industrial, technical and business sectors which have asked for the standards. Other experts with relevant knowledge, such as representatives of government agencies, testing laboratories, consumer associations, and environmentalists may also participate in the development of standards.
The process of making standards includes strategic planning, the project stage, work planning and timetabling, project management, preparing technological lists of errata and amendment sheets, coordination with institutions of registration and maintenance, citation of copyright and patent projects. The TCs and SCs are responsible for the entire process of making standards. The secretariat of the TCs and SCs, set up in a member country of ISO or IEC, manages the TCs and SCs. Thus, the member country that chairs the secretariat plays a key role in the process of making standards.

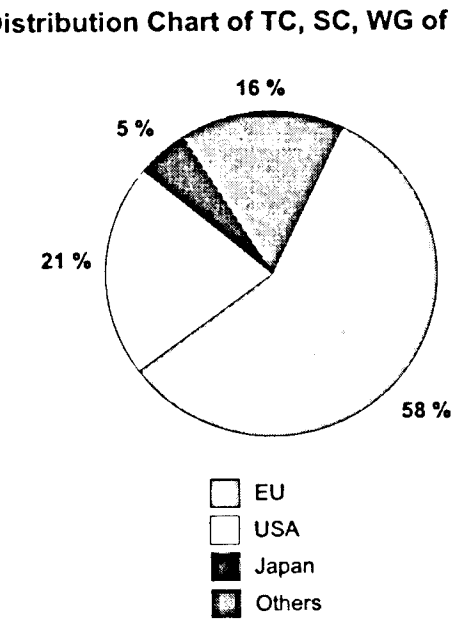


Figure: Distribution chart of TCs, SCs of IEC (© Song)

4.3 ISO and developing countries

ISO standards represent a reservoir of technology. Developing countries in particular, with their scarce resources, stand to gain from this wealth of knowledge. For them, ISO and IEC standards are an important means of both acquiring technological know-how backed by international consensus as state of the art and of raising their capability to export and compete in global markets. For example, in addition to these general benefits of ISO standards, ISO has a specific programme for developing countries that consists of training seminars, sponsorships/fellowships and publications. ISO also has a policy committee on developing country matters, DEVCO, with a membership of nearly 100 standards institutes from both industrialized and developing countries. However, these additional measures are of limited use in helping developing countries to participate in international standardization activities. Because international standards are created and amended mainly by developed countries, the weaker technical competences and lack of funds in developing countries create a barrier.

Therefore, it is imperative for international organizations such as ISO and IEC to develop a new mechanism which would allow more developing countries to participate in the making and amendment of international standards. If this is done, international standardization will be fairer and more balanced than it is at present.

4.4 ISO/IEC and China

As the above analysis has shown, both the leading positions of ISO and IEC and the secretariats of TCs and SCs are controlled by developed countries. This means that a country such as China, which has a significant international trade status, may not necessarily have a balanced representation in the activities of ISO and IEC. China reached $1.4221 trillion of total global import and export volume by the end of 2005, which made it the world's third largest international trading country by volume. It has fully realized the importance of participation in international standardization activities, and is striving to undertake more responsibility in the drafting of ISO and IEC standards. However, because of existing barriers for developing countries, China has been considered in only eight SC secretariats, which does not match its international trade status. Thus, China's international standards requirements are not effectively reflected or fully considered by ISO and IEC, which leads to unnecessary losses in its international trade. According to statistics of the Commercial Ministry of the People's Republic of China, the annual trade loss due to this problem amounts to $20 billion. Zhejiang, one of the biggest exporting provinces of China, suffers an economic loss of $2.55 billion, according to the statistics for 2004. These losses are unnecessary. Therefore, international standardization organizations should accept more opinions about international standards from developing countries and make it easier for developing countries to take part in all international standardization activities.

5 Influence of international standards on trade policies

5.1 Standards play a key role in trade

5.1.1 Standards as a licence to enter the market

Technical standards are important components of national trade policies. They exert great influence on international trade because standards are important factors in a product's ability to enter the market. Products are not to be sold in the market if they do not meet the requirements of relevant standards.
See: www.itu.inthome (the technical infrastructure of conformity assessment)

5.1.2 Case study

The Toys Directive 88/378/EEC was introduced in 1988 as a means to protect the health and safety of children. It identifies essential requirements to protect children from general risks (protection against health hazards or physical injuries) and particular risks (physical and mechanical properties, flammability, chemical properties, electrical properties, hygiene and radioactivity). In addition, the Directive requires the compilation of a Technical File that contains all the details regarding design, manufacture and operation of the toy, as well as test data and results. This document is the basis on which conformity with the Toys Directive is assessed. There are currently eight European harmonized standards (the 'EN 71' series) pertaining to the Toys Directive. Many local governments in China have developed policies to encourage toy manufacturers to adopt these standards for their enterprises. As a result, the growth of toy imports from China has increased at a stable speed.
See: www.wto.org (European toy imports from non-EU countries)

5.2 International trade based on international standards

5.2.1 WTO and national regulations adopting international standards

The WTO Agreement on Technical Barriers to Trade (TBT) and the Agreement on Sanitary and Phytosanitary Measures (SPS) discipline the preparation of mandatory standards, technical regulations and sanitary and phytosanitary measures. Both of these WTO agreements encourage governments to base technical regulations on international standards and to play a full part, within the limits of their resources, in the preparation of relevant international standards by appropriate international standardizing bodies. For instance, the code of

good practice contained in Annex 3 of the WTO/TBT Agreement seeks to bring all standards within its purview and provides for transparency in the preparation, adoption and application of standards. The code is open for acceptance by any of the following standardizing bodies: central, local governments, and non-government or regional standardizing bodies developing voluntary standards. Standardizing bodies which have accepted the code must report the existence of their work programme at least twice a year and indicate where details of the programme can be obtained. Notifications must be sent either directly to the ISO/IEC Information Centre in Geneva, or to the national member of ISO/IEC or, preferably, to the relevant national member or international affiliate of ISONET. In the case of Switzerland, the government may decide to financially support the development of such standards or to mandate national standardizing bodies to defend Swiss national interests in international standardizing bodies. In some countries, mandatory standards and technical regulations are typically developed by government agencies distinct from the standardizing bodies, while in other countries standardizing bodies develop both voluntary and mandatory or even only mandatory standards. The following figure shows the percentage share of mandatory standards developed by standardizing bodies by region. It is interesting to note that voluntary standards sometimes become mandatory de facto. In the United States, for example, wholesalers or retailers sometimes refuse to sell non-standard products because they do not wish to bear the responsibility in cases where such products create problems.

5.2.2 Case study

This dispute arose when the European Communities (EC) prohibited the use of the term 'Peruvian sardines' on tins containing sardine-like fish species (Sardinops sagax) caught off the Peruvian coast. The relevant EC regulation provided that only products prepared from Sardina pilchardus (the 'European sardine') could be marketed as preserved sardines. In other words, only products of this species were allowed to feature the word 'sardines' as part of the name on the container. A panel, established by the WTO Dispute Settlement Body (DSB) and confirmed in September 2002 by the Appellate Body, ruled in favour of Peru. It found that a standard set by the Codex Alimentarius Commission (CAC) for sardine products constituted a 'relevant international standard' under the TBT Agreement. The Codex standard set forth specific labelling provisions for canned sardines prepared from fish from a list of 21 species, including both Sardina pilchardus and Sardinops sagax. The Panel and Appellate Body ruled that this standard had not been used as a basis for the EC Regulation and that the standard was not 'ineffective or inappropriate' to fulfil the legitimate objectives pursued by the EC Regulation. Therefore, that regulation was declared inconsistent with TBT Article 2.4.
In July 2003, Peru and the EC informed the DSB that they had reached a mutually agreed solution to the dispute. According to the amended EC Regulation,

Peruvian sardines could be marketed in the EC under a trade description consisting of the word 'sardines' together with the scientific name of the species, i.e. 'Sardines - Sardinops sagax'. International standards play an important role in international trade. Many countries and regions cite relevant international standards in their trade policy. For example, ISO serial tea standards: ISO1573, ISO3103, ISO10727, ISO1576, ISO1578, ISO1577, ISO1572, ISO1575 have become national standards of China and are an important part of Chinese trade policy for tea. With the process of global economic integration, international standards will exert a greater influence on the formulation and the implementation of trade policy for all countries.

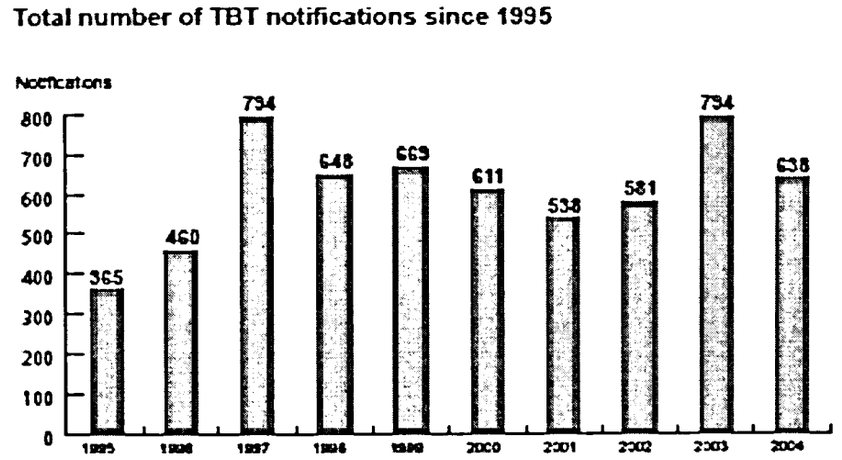


Figure: Total number of TBT notifications since 1995 (Source: WTO(2005a) Tenth Annual Review of the Implementation of the TBT Agreement G/TBT/15

5.2.3 International standards in China

The world is becoming smaller and smaller with the advancement of world economic integration. Unification of domestic and international markets is accelerating, and more and more uniform standards, i.e., international standards, are needed. Therefore, international standards are playing a more and more vital role. The importance of international standards in this area is reflected by the slogan 'one standard, one certification and world acceptance'.
China has been rapidly increasing its participation in the international market since its entry into the WTO. Import and export volume of trade reached

$1.4221 trillion by the end of 2005, and China became the third-largest trading country in the world. In order to speed up international trade development, the Chinese government has drawn up a policy ('Suggestions on Promoting the Adoption of International Standards') to encourage domestic enterprises to adopt international standards by issuing corresponding marks and certificates to products that are produced according to international standards. Chinese enterprises are also using international standards positively to enter the international market. For example, Zhejiang Babei Tie Company Limited has not only entered its products into the international market, but has also increased its economic efficiency progressively by 150% yearly as a result of adopting international standards. At present, the products produced by this company enjoy a good reputation in the international market.

6 Concluding remarks

The aim of this lecture has been to provide an introduction to international standardization. Hopefully, the reader will have gained an insight into not only the different international organizations for standardization, various international standards, the procedures and interrelations, but also into the historical circumstances that often have a significant impact on the development of international standardization. It is hoped that the reader will also be prepared to develop his/her own point of view with regard to international standardization. The reader who wishes to deepen his/her knowledge on international standardization topics may study the next section ('References') for more details. It is important to note that there have been remarkable success stories but also grand failures in the process of international standardization. There is reason for criticism. Who is more concerned with the interests of the current international standards, developing countries or developed countries? Who can get more profit from the international standardization process? Can the TBT be regarded as a success or is it a failure? These are intractable problems concerning international standardization.

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8 Glossary

ASTM
ASTM, originally known as the American Society for Testing and Materials (ASTM), was formed over a century ago. Today, ASTM plays a leadership role in addressing the standardization needs of the global market.

DEVCO
The DEVCO, known as the Committee on Developing Country Matters of ISO, aims to manage the developing plans of ISO, supply financial support and experts for developing standardization in developing countries.

DSB
The Dispute Settlement Body (DSB) of the WTO is made up of all member governments, usually represented by ambassadors or equivalent. DSB makes decisions on trade disputes between governments that are adjudicated by the Organization.

EC
EC means the European Communities. For legal reasons, the European Union is known officially as the European Communities in WTO business.

Economic integration
Economic integration is a term used to describe how different economies are integrated.

IEC
The International Electrotechnical Commission (IEC) is the leading global organization that prepares and publishes international standards for all electrical, electronic and related technologies. These serve as a basis for national standardization and as references when drafting international tenders and contracts.

IEEE
The Institute for Electrical and Electronics Engineers (IEEE). IEEE is the world's largest technical professional association, connecting more than 360,000 members in approximately 150 countries. It is a leading authority in technical areas ranging from computer engineering, biomedical technology and telecommunications to electric power, aerospace and consumer electronics, and others.

IESG
The Internet Engineering Steering Group (IESG) is responsible for technical management of IETF activities and the Internet standards process. As part of the ISOC, it administers the process according to the rules and procedures which

have been ratified by the ISOC Trustees. The IESG is directly responsible for the actions associated with entry into and movement along the Internet 'standards track', including final approval of specifications as Internet Standards.

IETF
The Internet Engineering Task Force (IETF) is a large, open international community of network designers, operators, vendors and researchers concerned with the evolution of Internet architecture and the smooth operation of the Internet. It is open to any interested individual.

International standards
Standard that is adopted by an international standardizing/standards organization and made available to the public.
[ISO/IEC Guide 2:2004, definition 3.2.1.1]

ISO
ISO, International Organization for Standardization, is a network of the national standards institutes of 153 countries, on the basis of one member per country, with its Central Secretariat in Geneva, Switzerland, which coordinates the system.

ITU
The ITU, International Telegraph Union, headquartered in Geneva, Switzerland, is an international organization within the United Nations System where governments and the private sector coordinate global telecom networks and services.

SC
SC is the abbreviation for subcommittee, a group which develops and maintains standards on the identification and description of information resources.

SCs
SCs is the abbreviation for subcommittees, the groups which make the standards.

SGs
SGs stand for the study groups which develop and maintain standards.

SPS Agreement
The WTO agreement on the application of sanitary and phytosanitary measures (SPS Agreement) is an agreement on how governments can apply food safety and animal and plant health measures (sanitary and phytosanitary or SPS measures). It sets out the basic rules in the WTO.

Standard
A document, established by consensus and approved by a recognized body, that provides, for common and repeated use, rules, guidelines or characteristics for activities or their results, aimed at the achievement of the optimum degree of order in a given context
NOTE: Standards should be based on the consolidated results of science, technology and experience, and aimed at the promotion of optimum community benefits. [ISO/IEC Guide 2:2004, definition 3.2]

TBT Agreement
TBT refers to the Technical Barriers to Trade. The Technical Barriers to Trade Agreement (TBT) tries to ensure that regulations, standards, testing and certification procedures do not create unnecessary obstacles.

TBT Article 2.4
Article 2.4 of TBT Agreement stipulates that "Where technical regulations are required and relevant international standards exist or their completion is imminent, Members shall use them, or the relevant parts of them, as a basis for their technical regulations".

TC
TC refers to a technical committee which develops and maintains standards.

TCs
TCs is the abbreviation for Technical Committees, which make standards.

UN
UN is the United Nations, which was established on 24 October 1945 by 51 countries committed to preserving peace through international cooperation and collective security. Today, nearly every nation in the world belongs to the UN; membership totals 191 countries.

WGs
WGs is the abbreviation for Working Groups, groups which make standards.

WTO
The World Trade Organization (WTO) is the only global international organization dealing with the rules of trade between nations. At its heart are the WTO agreements negotiated and signed by the bulk of the world's trading nations and ratified in their parliaments. The goal is to help producers of goods and services, exporters, and importers conduct their business.

9 Key questions

- What are the functions of IEC standards?
- What are the responsibilities of the Standardization Management Board (SMB)?
- Who produces the standards of IEC?
- What is the ISO in essence?
- What are the main purposes of ITU?
- What is the essence of the ASTM?
- Who develops ISO standards?
- How is the ISO system managed?
- What is the essence of the IEEE?
- What are TC, SC and WG?

Huala Adolf · Rudy Sayoga Gautama

Abstract

This lecture concentrates on the role of and the relationship between law and standardisation. At the outset, the lecture will highlight the role of international law in general. The international law on standardisation as embodied and concluded in the World Trade Organization will be discussed first. The discussion will include the issue of intellectual property rights, which to a greater extent have an important role to play with regard to standardisation. Not all issues under intellectual property rights are discussed. The focus will be on the rights of patent and copyright. In addition, the role of regional organisations in setting up their regulation on standards will be examined. These include the regional regulations in Europe (the European Union), Latin American countries and Asia.

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1 Preface

A law is made to ensure that certain activities can be conducted on an orderly basis. The law is also needed to ensure that any activities that will affect the interests of other people or interests may be protected. The law will also affect the functioning of standardisation. It is the law that obliges the actors or stake-holders in standardisation to take certain measures consonant with the prevailing law. The law is promulgated mostly by a formal institution of state. At the regional level, the law is drafted and concluded by the legislative body of the respective regional organisation. At the multilateral or international level, the law on standardisation is equally drafted and concluded by the legislative body of the said international organisation whose power is derived from the 'constitution' of the respective organisation. This lecture will demonstrate that international legislation (law) regulating standardisation will require its member states to adopt and implement the international law on standardisation into their national legislation. This requirement is necessary to ensure that the various national laws do not become an obstacle to international trade.

2 Introduction to International Law

2.1 Definition of International Law

International law is a living law. It is evolving and growing along with the development of the international community. Hence, the definition of this field of law is also reflected by the growth of the international community. Higgins is of the view that international law is a '*continuing process of authoritative decisions*'[1]. The definition of early writers, especially before the First World War, provided a rather simple definition of international law. J. Westlake, for example, defined international law as '*the law of the society of States or Nations*'[2]. The writers of the Second World War, for example H. Waldock, defined international law as '*the body of rules and principles of action which are binding upon civilized states in their relations with one another*'[3]. The development of international law, which is characterised by its content and scope, has made the previous definitions of international law somewhat irrelevant or outdated. International law at present no longer regulates the relationship between states.

[1] Rosalyn Higgins, Problems and Process: International Law and How We Use It, Oxford: Clarendon Press, 1994, p. 2.
[2] Sir Robert Y. Jennings, 'International Law', In: R. Bernhardt (ed.), Encyclopaedia of Public International Law, Instalment 7 (1984), p. 278.
[3] Sir Robert Y. Jennings, op.cit., p. 278.

It also regulates relations between states and international organisations, and other 'new' subjects of international law, which include individual, belligerents, and others. A 'modern' international lawyer tends to provide a rather complicated definition.

A noted international lawyer, J.G. Starke for example, defines international law as follows:
International law may be defined as that body of law which is composed for its greater part of the principles and rules of conduct which states feel themselves bound to observe, and therefore, do commonly observe in their relations with each other, and which includes also:

a) the rules of law relating to the functioning of international institutions or organisations, their relations with each other, and their relations with states and individuals.
b) certain rules of law relating to individuals and non-states entities so far as the rights or duties of such individuals and non-state entities are the concern of the international community.

Equally importantly, the growing thoughts and views on international law have contributed to the 'new' theory. Higgins, as stated above, viewed international law as 'rules' derived from 'authoritative decisions.' She contended that 'international law is the entire decision-making process and not just the reference to the trend of past decisions which are 'termed rules'[4]. The definition above states the sources of international law which specifically mentioned 'past decisions' in the definition. These include the decisions of the international courts. The other sources worth noting are international treaties, customary (international) law, the general principle of laws and the doctrines.

2.2 The Formation and Source of International Law

Unlike national law, international law is 'imperfect' law. The main problem of international law is its formation, i.e. how international law is formed and established. International law does not have an established 'constitutional machinery of law-making as exists in national law'[5]. This includes the non-existence of permanent legislative, executive and judicatory bodies.

[4] Rosalyn Higgins, op.cit., p. 2.
[5] Ian Brownlie, Principles of Public International Law, Oxford: Clarendon Press, 5th ed., 1998, p. 1.

Furthermore, the other weakness of international law is the non-existence of an (international) police force whose function is, among other things, to enforce international law when it is breached. Because of these characteristics and weaknesses, some lawyers contended that international law was a branch of ethics rather than law[6]. The above statement cannot be maintained. International law is binding and states observe it in their international relations. The binding force of international law may be found in their sources. One of the most important sources is treaties. It is the treaties that bring about states' initial consent or agreement to be bound by them. As J.G. Merrills observed: 'Because there is no world government or international legislature, international law is largely made by states themselves. The creation of international law is therefore a matter of international agreement.'[7]

In addition to treaties, the other instrument similar to treaties is the decision of (private) international organisations. These instruments, also called 'soft law', have been growing in recent years. They are 'soft' law mainly because their binding force is not the same as that of treaties. They are instruments issued by most private international bodies, which mostly only bind their members.[8] These instruments may include decisions, model law or model clauses, or standardisation issued by international standards organisations, such as ISO. The other important source of international laws that demonstrates their observance is custom. Custom shows the practice of states in their international relations 'has been broadly consistent and that in so acting they have exhibited opinio juris, that is, they have treated the matter as one of legal obligation'[9]. The main issue that is worth noting is the relationship between international law and national law. The description above shows that international law is a living law that binds the state and other subjects of international law. The binding force of international law upon the subjects of international law, especially the states, is not automatic. It has been stated above that international law is created mainly by the agreement of the states that agree to formulate and to be bound by it. The emergence of new rules of international law does not mean that such new rules will automatically bind the states.

6 D.J. Harris, Cases and Materials on International Law, London: Sweet and Maxwell, 6th ed., 2004, p. 2.
7 J.G. Merrills, Anatomy of International Law, London: Sweet and Maxwell, 2nd ed., 1981, p. 3.
8 Under international law, such decisions may also be called 'codes of conduct'. See further: Ernst-Ulrich Petersmann, 'Code of Conduct', in: R. Bernhardt (ed.), Encyclopaedia of Public International Law, Instalment 7 (1987), pp. 28-29.
9 J.G. Merrills, op.cit., p. 4-5.

The states will be bound by such rules if only the said states have expressly stated their consent to be bound by these 'new rules.' In addition, there are certain constitutional processes that should be included in the legal system of every state with respect to how international law may be applicable in the said state's territory. One of the most common instruments is to ratify the new rules (if they are embodied in the agreements, conventions or treaties). This act of ratification will usually be followed with the promulgation of their national law regulating the objects that are embodied in international law.

3 Possible Relations of Standards to National Law

Standards are usually set up by a national standardisation body or other standardisation bodies dealing with certain technical or non-technical standards. Since standards are applied within a state (national) territory, a problem which may then arise is whether there is any possible relation of standards to national law. At the outset, it might be right to conclude that there is a close relationship between standards and national law. National law is drafted and promulgated by the legislative power of a state. Once it is promulgated and published in a state gazette, it becomes national legislation that binds its citizens or legal subjects living within the state territory. The policy of a state to set its national standards will be implemented through its national law. Therefore, it is through its national law that a certain standard will be effective and implemented. The use of national law to enforce standards may be well understood in the light of the role of law. As Rosalyn Higgins put it: "...to provide an operational system for securing values that we all desire - security, freedom, the provision of sufficient material goods.'[10]

National law will to a greater extent determine the sanctions to be imposed on those who breach the mandatory national standards. Furthermore, national law will also embody and implement the international agreement(s) concerning standards to be applied in its territory. This is usually the case as the consequence of the decision by a state to become a member of an international organisation, for example, ISO. Furthermore, national law will also determine its national standards body. Equally, national law will specify the function, role and power that the national standards body shall have.

10 Rosalyn Higgins, op.cit., p. 1; Cf., Samuel Mermin, Law and the Legal System: An Introduction, Boston, Toronto: Little, Brown and Co., 2nd ed., 1982, p. 6. (According to the present author, the terms common expectations may include standardisation. Mermin is of the opinion that the function of the law '... is a framework within which certain common expectations about relationships, planned happenings, and accidents of daily life can be met').

Be that as it may, there is a view that suggests that standardisation is not related to national law. This view holds that 'standardisation is an activity entirely separable from regulatory development. This activity is led by industry and with complete independence from a regulator[11]. Seen from the definition of standards, for example as provided for by ISO, WTO[12], no single word of law or legislation is mentioned. Therefore, it suggests that there is no relation at all between law or legislation and standards[13]. The view above cannot be true, however. Although the standards may be issued by an independent body and therefore have no connection whatsoever with the government or other government-related agencies, standards that apply within the territory of a state, to a greater extent, are within the national jurisdiction of that state. Still, there are public interests that may be affected by such standards. These interests include, for example, the protection of consumers, workers (safety, hygiene, health, prevention of fraud)[14], or animal and plants.

4 Intellectual Property Rights

4.1 Definition of Intellectual Property Rights

The intellectual property right (IPR) is a recent phenomenon, especially in international trade law. This issue arises in line with the growing concerns and needs to protect IPRs[15]. Additionally, a minimum standard of protection and enforcement of intellectual property rights is needed.[16] However, it is difficult to provide a clear and accepted definition of intellectual property rights. The international agreement on IPR, especially the Trade Related Aspects of Intellectual Property Rights (TRIPs) Agreement does not provide any definition of IPR, either[17]. The TRIPs Agreement only states that IPRs are all categories of intellectual property, which include copyright and related rights, trademarks, geographical indications, industrial designs, patent, layout designs (topographies) of integrated circuits, protection of undisclosed information.

[11] OECD, 1999, p. 33, esp. para. 154.
[12] See the definition of standards below.
[13] OECD, 1999, p. 33, esp. para. 154.
[14] OECD, 1999, p. 19.
[15] Paul Katzenberger and Annette Kur, 'TRIPs and Intellectual Property', in: Friedrich-Karl Beier and Gerhard Schricker (eds.), From GATT to TRIPs: The Agreement on Trade-Related Aspects of Intellectual Property Rights, Weinheim and New York: VCH Publ., 1996, p. 7. (Katzenberger and Kur also suggest the need for IPR Protection was based on the following factors: 'the increasing economic importance; the deficits in traditional international protection of these rights and the questionable nature of unilateral and bilateral protection alternatives').
[16] WTO, Trading into the Future, Geneva: WTO, 1995, p. 26.
[17] Annex IC of the Agreement Establishing the World Trade Organization.

The definition above indicates that IPRs deal generally with protecting the application of ideas and information that have a certain, if not substantial, economic or commercial value[18]. Thus an IPR is the property that may be owned by legal subjects and shall be treated as similar to other properties[19].

4.2 Definition of Patent

A patent is defined as 'the exclusive right to make, use, or sell an invention for a specified period (usu. 20 years), granted by the federal government to the inventor if the device or the process is novel, useful, and non-obvious'[20]. The main international agreement on the protection of patents is embodied in Articles 27 to 34 of the TRIPs Agreement. The TRIPs Agreement obliges members to make patents available for both product and process inventions in all fields of technology 'provided that they are new, involve an inventive step and are capable of industrial application'[21]. The patent is given protection for a certain time. The purpose of this protection, where the subject matter of a patent is a product, is 'to prevent third parties not having the owner's consent from the acts of: making, using, offering for sale, selling, or importing for these purposes that product'[22] .
Similarly, when a patent is a process, the protection is given 'to prevent third parties not having the owner's consent from the acts of using the process, and from the acts of: using, offering for sale, selling, or importing for these purposes at least the product obtained directly by that process'[23]. In return, the patent holder is required to publish the details of his invention so that when the time of protection lapses, the information concerning the invention will be available to the public[24]. The TRIPs Agreement states the term of protection is no less than twenty years from the filling date[25]. Generally, patent holders get 16-20 years of protection[26].

[18] Katzenberger and Kur, op.cit., p. 8.
[19] Tim Lindsey et al. (eds.), Hak Kekayaan Intelektual: Suatu Pengantar (transl.: Intellectual Property Rights: An Introduction), Bandung: Asian Law Group and Alumni, 2002, p. 3.
[20] Bryan A. Garner, Black's Law Dictionary, Second Pocket Dictionary, West Publishing Co., 2001, p. 517 (citing 35 ISCA Articles 101-103). [Hereinafter cited as Black's Law Dictionary).
[21] Article 27 of the TRIPs Agreement; see also Joseph Straus, 'Implications of the TRIPs Agreement in the Field of Patent Law', in: Friedrich-Karl Beier and Gerhard Schricker (eds.), op.cit., p. 180.
[22] Article 28 (1) (a) of the TRIPs Agreement.
[23] Article 28 (1) (a) of the TRIPs Agreement. See also Joseph Straus, op.cit., p. 198.
[24] Article 29 of the TRIPs Agreement; Tim Lindsey, op.cit., p. 7.
[25] Article 33 of the TRIPs Agreement.
[26] Tim Lindsey, op.cit., p. 7.

4.3 Definition of Copyright

Copyright is 'a property right in an original work of authorship (such as a literary, musical, artistic, photographic, or film work) fixed in any tangible medium of expression, giving the holder the exclusive right to reproduce, adopt, distribute, perform, and display the work'[27]. Copyright has been subject to international agreements for years. The main multilateral agreement on copyright is the Revised Berne Convention. Other important agreement includes the TRIPs Agreement[28]. Principally the copyright is the right to copy. The copyright provides the right to the work to control and use the work, which principally is to prevent other parties from copying an author's work without his or her permission. Traditionally, copyright was given to books. Today, copyright is given to other works, including literary works, drama, music and artistic works, sound recordings, broadcasting of sound, of films and television and computer programs. In general, the term of protection of a work is no less than 50 years from the end of the calendar year of publication. If such publication is not available, the term of protection is also 50 years counted from the end of the calendar year of production[29].

4.4 Definition of Standards

However, there is no uniform and single definition of standards accepted by major international or national standardisation bodies. Nevertheless, most definitions have one voice, namely the elements contained in the definitions. While other aspects of the definition, such as whether a standard can be developed or subsequently used as a regulatory instrument or not, or the nature of standards, namely whether it is voluntary or mandatory, standards are still diverse.The word "standard" has been defined by a number of international and regional as well as national legislation.

[27] Black's Law Dictionary, op.cit., p. 146.
[28] Articles 9-14 of the TRIPs Agreement. Other important agreements on copyright with its 55 members are the Universal Copyright Convention and the Rome Convention (International Convention for the Protection of Performers, Sound Recordings and Broadcasting). 57 countries are parties to the Convention (Tim Lindsey, op.cit., p. 98. See further, Paul Katzenberger, 'TRIPs and Copyright Law', in: Friedrich-Karl Beier and Gerhard Schricker (eds.), op.cit., p. 60.
[29] Article 12 of the TRIPs Agreement.

Firstly, the ISO's definition of standards is the following:
'Document, established by consensus and approved by a recognised body, that provides for common and repeated use, rules and guidelines or characteristics for activities or their results, aimed at the achievement of the optimum degree of order in a given context.'[30]
ISO's definition above is adopted by the WTO. The WTO Agreement on Technical Barriers to Trade defines standard as follows:
'Document approved by a recognised body, that provides, for common and repeated use, rules, guidelines or characteristics for products or related processes and production methods, with which compliance is not mandatory. It may also include or deal exclusively with terminology, symbols, packaging, marking or labelling requirements as they apply to a product, process or production method.'[31]

Within a regional institution, the EC, for example, in directive 98/34/EC, puts forward the following definition:
'A specification contained in a document which lays down the characteristics required of a product such as levels of quality, performance, safety or dimensions, including the requirements applicable to the product as regards the name under which the product is sold, terminology, symbols, testing and test methods, packaging, marking, labelling and conformity assessment procedures.'[32]

Standards may be categorised as follows:
1. Technical regulations
2. Standards that are legally set up, which include:
    a. International standards (for example: standards issued by ISO, IEC, ITU, CODEX);
    b. Regional standards (CEN/CENELEC); and
    c. National standards (BSI, AFNOR, DIN, JISC).
3. Standards existing on products, for example: Windows, TCP/IP, etc.
4. Company standards.

[30] ISO also provides a shorter version of the definition of standards as follows: 'Standards are documented agreements containing technical specifications or other precise criteria to be used consistently as rules, guidelines, or definitions of characteristics, to ensure that materials, products, processes, and services are fit for their purpose.' (<http://www.iso.ch>); Steven M. Spivak and F. Cecil Brenner, Standardization Essentials: Principles and Practice, New York, Basel: Marcel Dekker Inc., 2001, p. 2. (Spivak and Brenner define standard as 'a uniform set of measures, agreements, conditions, or specifications between parties; the latter may be buyer-seller, manufacturer-user, government-industry or government-governed, retailer-manufacturer-consumer, or any other parties').
[31] Agreement on Technical Barriers to Trade, Annex 1; see also: Harm Schepel and Josef Falke, Legal Aspects of Standardization in the Member States of the EC and EFTA, Volume 1: Comparative Report, Belgium: EC, 2000, p. 91.
[32] Harm Schepel and Josef Falke, Ibid., p. 91. It should be also noted that in addition to the definition of standards,the definition of international standards deserves attention. This definition arises because the term 'international standard' suggests that there is an international standard belonging to or produced by a certain standardisation body. In addition, the definition is also difficult, and complicated by the fact that standard-makers themselves do not agree on the definition. The OECD however has tried to give the short definition of international standards as follows: 'a standard with a significant de facto international use and acceptability.' (OECD, 1999, p. 8, especially para. 31).

5 Copyright Law

The above analysis of copyright described the various international agreements relating to copyright which have been ratified by many countries. They include the Berne Convention (1971), the TRIPs Agreement, the Universal Copyright convention and the Rome Convention. The international agreements above try to promote harmonisation and even uniformity in copyright law as well as to advocate better protection for the copyright holder. It is worth noting that, with the existence of these international agreements, the scope of the objects or works protected under copyright law have expanded. As noted earlier, the area of copyright protection used to be limited to books. With the advancement of technologies and the expansion of the creativity resulting from ideas, protection is now also given to other literary works, including drama, collections of data, even computer programs, etc.

The scope of copyright protection does not mention the results of ideas in the form of standards. The question that arises from the publication of the standards is the issue of the copyright. Are the standards made available to all interested parties protected under the copyright? There is no uniform, single and accepted answer to this question. Similarly, the practice of states differs. Some national legislation provides that all standardisation bodies at the national level have copyright protection for their standardisation.

In Ireland, for example, standards law explicitly provides for it:
'The copyright of format and content of any Irish Standard Specification or other publication of the Authority shall vest exclusively in the Authority and any person who, without the written authorisation of the Authority, publishes, reproduces or records in any manner or form any document or part thereof in respect of which copyright vests in the Authority shall, (...) be guilty of an offence.'[33] Similar policy where standardisation is protected by copyright is found in Austria, the Netherlands, Spain and the United Kingdom[34]. Jordan also follows this policy. According to the government of Jordan, the standard is created through a collective work. 'The national standard is programmed and studied under the authority of the national standards body. It is published by the latter. It is therefore protected, as early as at the draft standard stage, by a copyright belonging to the national body.'[35]

[33] Harm Schepel and Josep Falke, op.cit., p. 169. Cf., 'international standards are protected by the copyright of the international standards body (ISO, IEC). The exploitation right of this copyright is automatically transferred to the national standardisation bodies which comprise the membership of ISO or IEC, for the purpose of drawing up national standards. The national standards body is under obligation to take all appropriate measures in order to protect the intellectual property of ISO and IEC on the national territory. Each draft International Standard and each published International Standard bears a copyright statement with the international copyright symbol, the publisher's name and the year of publication.'
[34] http://www.jism. gov.jo/english/standardization/standardization.htm.
[35] Harm Schepel and Josep Falke, op.cit., p. 170.
<http://www.jism.gov.jo/english/standardization/standardization.htm>

Likewise, some European standardisation institutions, for example the European Committee for Standardisation (CEN), the European Committee for Electrotechnical Standardisation (CENELEC), or the European Telecommunications Standards Institute (ETSI), claim copyright on standardisation they publish[36]. These European institutions may grant the copyright to the national standardisation bodies by concluding an agreement. ' The contents of these agreements are exemplified by CEN/CENELEC Memorandum Policy for the distribution and sales of CEN/CENELEC publication in all formats.

The agreement, among other things, states:
'The CEN/CENELEC national members have, within their own territory, the right to distribute, subdistribute, adjust, translate, rent, lend, derive venue from duplication and loan, communicate to the public in total or in part, in summary or in comments, transfer all exploitation licences and authorise all sub-licences and otherwise exploit the CEN/CENELEC publications.'[37]
National law in France does not permit the claim on copyright. Other countries provide that once standardisation has the status of an official act expressing the state's will it shall lose copyright protection[38]. The yardstick used to determine whether a standard is subject to copyright is the requirement of originality and the official text exception. The former may be easily met to a certain degree[39]. However, the standards may not be subject to the copyright if it has to meet the official text exception. Most national laws state that the acts of law, regulations, court decisions and administrative documents are excluded from copyright protection[40]. Since standardisation may be qualified as administrative documents[41], then it is excluded from the copyright protection.

6 International Law Relating to Standardisation

6.1 Standardisation under GATT

The need for regulation on standardisation has been long recognised under world trade rules. The first regulation to be found was under the General Agreement on Tariffs and Trade (GATT). Under Article XX of GATT, a contracting party of GATT may set up certain measures, including standardisation, in order to protect humans, plants and animals. Other articles concerned with standards are Articles III and XIX of GATT.

[36] Harm Schepel and Josep Falke, op.cit., p. 167.
[37] Harm Schepel and Josep Falke, op.cit., p. 167.
[38] Harm Schepel and Josep Falke, op.cit., p. 171.
[39] Harm Schepel and Josep Falke, op.cit., p. 169.
[40] Harm Schepel and Josep Falke, op.cit., p. 169.
[41] See the definition of standardisation above.

GATT also imposes on the contracting parties certain requirements to implement such standards in order to protect its humans, plants and animals[42]. In addition, the article implicitly requires that such standards may not lead to discrimination against foreign products or to create unnecessary obstacles to foreign products.

6.2 Standardisation under the Tokyo Round Negotiations

Article XX of GATT was further developed during GATT's Tokyo Round negotiations on technical barriers. The Tokyo Round stated that technical regulations were important in society. They were necessarily adopted to meet certain needs in the society. They included the protection of human and animal life and health; the assurance that products offered to consumers meet the necessary levels of quality, purity, technical efficiency and adequacy to perform the function for which they are intended; the protection of the environment, national security; and the prevention of deceptive practices[43]. It is worth noting that during the negotiations, this issue had raised concerns among the participants. They stated that they had difficulties in dealing with this issue. There were about 150 notifications in the non-tariffs measures[44].

However, GATT realised that some international organisations have been dealing with the issue of standardisation for a long time. To prevent the duplication of work, GATT's position was rather practical. On this issue, GATT's negotiations and the results attained in the negotiations would '*complement, not conflict with the activities of the many other international organisations.*' They included the International Organization for Standardization (ISO), the International Electrotechnical Commission (IEC). The result of the Tokyo Round on Technical Barriers to Trade was the adoption of the agreement called 'Agreement on Technical Barriers to Trade', also known as the Standards Code.

[42] Article XX GATT
[43] Report of the Secretary General of GATT, The Tokyo Round of Multilateral Trade Negotiations, 62-63 (1979), as quoted by John H. Jackson, et al., Legal Problems of International Economic Relations, West, 1979, p. 533.
[44] Report of the Secretary General of GATT, The Tokyo Round of Multilateral Trade Negotiations, 62-63 (1979), as quoted by John H. Jackson, et al., Legal Problems of International Economic Relations, West, 1979, p. 533.

The Standards Code laid down a number of obligations on contracting parties with regard to standardisation. They included[45]:

Article 2:
With respect to their central government bodies:
2.1 Parties shall ensure that technical regulations and standards are not prepared, adopted or applied with a view to creating obstacles to international trade. Furthermore, products imported from the territory of any Party shall be accorded treatment no less favourable than that accorded to like products of national origin and to like products originating in any other country in relation to such technical regulations or standards.

2.2 Where technical regulations or standards are required and relevant international standards exist or their completion is imminent, Parties shall use them, or the relevant parts of them, as a basis for the technical regulations or standards (except if they are inappropriate for specified reasons).

2.3 With a view to harmonizing technical regulations or standards on as wide a basis as possible, Parties shall play a full part within the limits of their resources in the preparation by appropriate international standardizing bodies of international standards for products which they either have adopted, or expect to adopt, technical regulations or standards.

2.4 Wherever appropriate, Parties shall specify technical regulations and standards in terms of performance rather than design or descriptive characteristics.

2.5 Whenever a relevant international standard does not exist or the technical content of a proposed technical regulation or standard is not substantially the same as the technical content of relevant international standards, and if the technical regulation or standard may have a significant effect on trade of other Parties, Parties shall: [publish a notice of their intention to adopt a particular regulation or standard, inform the GATT secretariat of the products affected, provide copies of the proposals to interested parties and consider comments on the proposals, publish the regulations or standards promptly and provide a phase-in period].

[45] John H. Jackson, et al., Legal Problems of International Economic Relations, West, 1979, p. 534-535. This Code, however, did not call for harmonisation of technical standards. Neither did it explicitly regulate on the safety issue. It only called for international cooperation and the elimination of non-tariff barriers (see notably article 2 above). (OECD, Consumers, Product Safety Standards and International Trade, France: OECD, 1991, p. 51).

Article 3
3.1 Parties shall take such reasonable measures as may be available to them to ensure that local government bodies within their territories comply with the provisions of Article 2 (with certain exceptions).

Article 4
4.1 Parties shall take such reasonable measures as may be available to them to ensure that non-governmental bodies within their territories comply with the provisions of Article 2 (with certain exceptions).

Article 5
Determination of Conformity with Technical Regulations or Standards by Certain Government Bodies.

5.1
...parties shall ensure that, in cases where a positive assurance is required that products conform with technical regulations or standards, central government bodies apply the following provisions to products originating in the territories of other Party.

5.1.1
...imported products shall be accepted for testing under conditions no less favourable than those accorded to like domestic or imported products in a comparable situation.

5.1.2
...the test methods and administrative procedure for imported product shall be no more complex and no less expeditious than the corresponding methods and procedures, in a comparable situation for the like products of national origin or originating in any other country.
...the Agreement states that it is the right of member countries to adopt technical regulations that prescribe mandatory products standards (including packaging and labelling requirements)[46].

[46] Preamble, TBT Agreement; Business Guide, p. 117

6.3 Standardisation under the WTO Agreement

6.3.1 The Technical Barriers to Trade

The World Trade Organization (WTO) pays more serious attention to the standardisation issue. It was felt that states had implemented more technical barriers than those of the 1970s when the Tokyo Round was concluded. One of the Agreements under the covered agreements of the WTO that specifically deals with standardisation is the Technical Barriers to Trade Agreement (hereinafter referred to as 'TBT Agreement'). This Agreement replaces the Standard Code of the Tokyo Round[47]. The TBT Agreement recognises that the technical requirements and industrial standards are important. On the other side of the coin, however, these regulations may differ among members of the WTO. These differences may inevitably create difficulties for producers and exporters. It is similarly recognised, however, that these technical regulations and standards may be exercised arbitrarily. They may be used as a disguised protection and barriers to international trade. Thus, the Agreement obliges member countries to ensure that their technical regulations are not used to create obstacles to other exporters to export their products. The Agreement lays down a number of requirements upon member countries when applying their standards.

They include:
- they must not be formulated and applied in a way to cause an 'unnecessary obstacle to trade;
- they must not give more favourable treatment to imported products than that given to domestically produced products (national treatment principle)[48];
- they must be applied on an MFN condition to imports from all sources[49];
- they must be based on scientific information and evidence[50].

The TBT Agreement requires the member countries to adopt international standards when formulating its national standards. However, this requirement is not mandatory. The requirement may be set aside if the national authorities think that the international standards would be ineffective or inappropriate given the climatic, geographical, or technical factors[51]. In addition, the Agreement calls on WTO member countries to take an active part in the work of international organisations dealing with standardisation such as the International Organization for Standardization (ISO)[52].

[47] Hans Schepel and Falke, op.cit., p. 41.
[48] Article 2.2 TBT Agreement; Business Guide, p. 118.
[49] Article 2.2 TBT Agreement; Business Guide, p. 118.
[50] Article 2.2 TBT Agreement; Business Guide, p. 119.
[51] Article 2.4 TBT Agreement; Business Guide, p. 119. Another reason that may justify this provision is that every state has different economic growth and conditions. It may be plausible to note that developing country members or less developed country members may have difficulties in setting their products to international standards.
[52] Article 2.4 TBT Agreement; Business Guide, p. 119.

Standards are mandatory upon some products. In such a case, the Agreement lays down certain requirements upon the said member countries. When member countries apply their national standards, the TBT Agreement sets out procedural rules to be followed. Firstly, member countries are required to publish a notice and to notify the WTO Secretariat about their technical regulations which are not based on existing international standards[53]. Secondly, it may be the case that member countries require a positive assurance of conformity with technical regulations or standards from a recognised institution or laboratory in the importing country. This requirement usually indicates that such assurance should meet the following conditions[54]:

- conformity assessment procedures must be based upon the national treatment principle. Thus, they must not accord foreign suppliers treatment that is less favourable than that accorded domestic suppliers;
- the selection of samples for testing should not be made so as to cause inconvenience to foreign suppliers;
- any fees charged to foreign suppliers should be equitable in relation to those chargeable for products of domestic origin.

6.3.1.1 Mutual Recognition of Certificates of Conformity Assurance

The TBT Agreement also encourages members to recognise the results of the standardisation carried out by the other members' standardisation body. This recognition may be given if the product standards and the procedures for assessment of conformity are similar to their own. However, this recognition is not usually given automatically. The TBT Agreement urges the members to enter into the agreement on the mutual recognition of conformity assessment. It is common that agreement on this matter may be reached when the importing country has been convinced and satisfied with the technical competence of the conformity assessment body of the exporting country[55].

6.3.1.2 Obligations of Local Government Bodies

In a number of countries, technical regulations imposing mandatory standards and systems for assessing conformity with such standards are formulated and applied, not only by central government bodies but also by local and non-governmental bodies. The Agreement imposes a binding obligation on member countries to require their central government bodies to abide by their discipline in formulating and applying mandatory standards. However, as the constitutions of some countries do not allow the central governments that are signatories to the Agreement to assume binding obligations on behalf of local

[53] Article 2.9 TBT Agreement; Business Guide, p. 119.
[54] Article 5 TBT Agreement; Business Guide, p. 120.
[55] Article 6 TBT Agreement; Business Guide, p. 121.

bodies, it calls on these governments to 'take such reasonable measures as may be available to them' to ensure that these local bodies abide by the Agreement's discipline[56].

6.3.1.3 Voluntary Standards

As noted earlier, many of the standards used by industries and exporters are voluntary standards. These are often formulated by a number of standardisation bodies, including national standardisation bodies. Voluntary standards can create problems in international trade if they vary widely from country to country. The Agreement therefore developed a Code of Good Practice with which national standardisation bodies are expected to abide in preparing, adopting and applying their standards.

The code requires national standardisation bodies to abide by principles and rules that are similar to those specified for mandatory standards. Thus, the code urges them:

- to use international standards as a basis for their national standards;
- to participate fully within the limits of their resources, in the preparation of international standards for products for which it proposes to adopt national standards.

Furthermore, there is another obligation on the part of the national bodies undertaking the standardisation. The TBT Agreement requires these bodies to publish their work programme 'at least once every six months', giving information on the standards that they are preparing and the standards they have adopted in the preceding period. At the time of publication, the national bodies are also required to notify the ISO/International Electrotechnical Commission (IEC) information Centre of the name of the publication and how and where it can be obtained[57]. The step above is to fulfil the transparency requirement as one of the principles embodied in the TBT Agreement. This step is intended to familiarise the standardisation being undertaken by these national bodies by exporters and importers. The Code also requires standardisation bodies to give no less than 60 days for the interested parties to make their comments. However, the comments are not binding in nature. The Code encourages the standardisation bodies formulating the standard to take these comments into consideration. The code calls on the standardisation bodies formulating the standard to take these comments into account when finalising the standard[58].

[56] Article 7 TBT Agreement; Business Guide, p. 121.
[57] Article 4 TBT Agreement Annex 3; Business Guide, p. 121
[58] Annex 4 TBT Annex 3; Business Guide, p. 122-123

6.3.2 The Sanitary and Phytosanitary Agreement

As its name suggests, the Sanitary and Phytosanitary (SPS) Agreement deals primarily with standards concerning agricultural products. Among other things, these may include plants, fruits and vegetables, meat, meat products and other food products. Some countries may require these products to meet sanitary and phytosanitary regulations as well as product standards. They may also restrict the export and import of these products if they do not meet certain requirements including the quality requirements specified by regulations[59]. The SPS Agreement sets out the principles and rules that member countries must adopt in regulating imported products.

The Agreement defines sanitary and phytosanitary measures as measures taken to protect human, animal or plant life or health:

- '...from risks arising from the entry, establishment or spread of pests, diseases, disease-carrying organisms or disease-causing organisms;
- '... from risks arising from additives, contaminants, toxins or diseases-causing organisms in food, beverages or foodstuffs;
- '... from diseases carried by animals, plants or product there of.'[60]

Like the TBT Agreement, the SPS Agreement contains the following requirements:

1) The adoption of international standards is recommended. The member countries are required to base their SPS regulations upon international standards, guidelines or recommendations[61]. This is necessary to create harmonisation of standards among the member countries. It is expected that the adoption of standards by members will not create an obstacle to trade.

2) Active participation in international organisations dealing with standardisation is encouraged. The member countries are required to take a full part in the activities of international organisations; notable among these are the Codex Alimentarius Commission, International Office Epizootics and International Plant Protection Convention, in order to promote the harmonisation of SPS regulations[62].

[59] Business Guide, p. 123.
[60] Annex A SPS; Business Guide, p. 123-124.
[61] SPS Preamble; Business Guide, p. 124.
[62] SPS Preamble; Business Guide, p. 124.

3) Publication of the Draft Standards and Regulations

Like the TBT Agreement, the SPS Agreement also allows the members to adopt their national standards. In such a case, the SPS Agreement requires that the national standards embodied in the (draft) regulations, be published to give other member countries an opportunity to make their comments on them. The basic purpose of this rule is to ensure that regulations adopted take adequate account of the production and other standards prevailing in other countries. The main responsibility for providing such comments falls on the producing and exporting industries[63].

4) Recognition of Exporting Countries' Standards is Encouraged

The SPS Agreement encourages member countries to accept the SPS measures of exporting countries as equivalent if they achieve the same level of SPS protection[64].

The SPS Agreement, however, differs from the TBT Agreement. These differences include:

First, the TBT Agreement requires that product standards should be applied on an MFN basis. The SPS Agreement permits standards to be applied on a discriminatory basis, provided that they 'do not arbitrarily or unjustifiably discriminate between Members where identical or similar conditions prevail'. The rationale for this treatment is that sometimes it is not always appropriate to impose the same SPS standards on animal and plant products originating from different countries. The main reasons that are plausible, among other things, are the different food and other agricultural production conditions, the culture or even the beliefs of the society[65].

Secondly, the SPS Agreement provides greater flexibility for countries to deviate from international standards than is allowed under the TBT Agreement. The TBT Agreement allows a country to deviate from international standards if this is necessitated by 'fundamental climatic or geographical factors or fundamental technological problems'. Its provisions thus make it clear that the adoption of a standard that is different (either lower or higher) will have to be justified on scientific or technical grounds[66].

[63] Business Guide, p. 130
[64] Art 4 SPS Preamble; Business Guide, p. 124. (This is the principle of recognition which is also recognised by the TBT Agreement).
[65] Art 2:3 SPS Agreement; Business Guide, p. 125. In Indonesia, for example, the imported meat or foods that will be sold on the domestic market must meet the 'halal' requirement. This requirement is adopted since the majority of the people are Muslim.
[66] Art 2:3 SPS Agreement; Business Guide, p. 125.

The SPS Agreement, on the other hand, states that a country may introduce or maintain an SPS measure resulting in a higher level of SPS protection than that achieved by an international standard if there is scientific justification or when the country determines that a higher level of protection would be appropriate. In the latter case, the Agreement offers certain guidelines. It states that the appropriate level of protection should be based on an assessment of risk appropriate to the circumstances, available scientific evidence, relevant process and production methods and the prevalence of specific diseases or pets[67].

Thirdly, in assessing the risk to animal or plant life or health, economic factors such as the establishment or spread of pets or diseases, the costs of control or eradication in the importing member country, and the relative cost-effectiveness of alternative approaches to limiting risk should be taken into consideration[68].

Fourthly, in determining the appropriate level of SPS protection, the objective of preventing or avoiding negative trade effects should be taken into account[69]

Fifthly, the SPS Agreement permits countries to adopt SPS measures on a provisional basis, as a precautionary step, in cases where there is imminent risk of the spread of diseases, but the 'scientific evidence' is insufficient[70].

One of the main problems enterprises face in developing export trade is the lack of adequate information about the standards and health and sanitary regulations applicable to their products in target markets.

In helping enterprises obtain such information, the SPS Agreement requires each member country to establish enquiry points from which information can be obtained by interested business enterprises on:[71]

- SPS regulations adopted or to be adopted;
- conformity assessment procedures, adopted or proposed to be adopted;
- control and inspection procedures, production and quarantine treatment, pesticide tolerance treatment and food additive approval procedures;
- risk assessment procedures;
- technical regulations and voluntary standards adopted or proposed to be adopted.

[67] Art 5:2 SPS Agreement; Business Guide, p. 126.
[68] Art 5:3 SPS Agreement; Business Guide, p. 126.
[69] Art 5:4 SPS Agreement; Business Guide, p. 126.
[70] Art 5:7 SPS Agreement; Business Guide, p. 126.
[71] Annex B:3, SPS, B6, Business Guide, p. 127-128. This provision is also found in Article 10 TBT Agreement. (Appendices I and II list the enquiry points that have been established by different member countries under the provisions of the TBT and SPS Agreements).

As can be seen, the SPS Agreements, including the TBT Agreement, tries to protect the interests of foreign suppliers. It does this by requiring that standards - both mandatory and voluntary - as well as health and sanitary standards should not be formulated and applied in such a way as to cause unreasonable barriers to trade. It is therefore in the interest of the exporting enterprise to examine whether the product standards, health or sanitary regulations or the testing and inspection requirements of their export markets conform with the criteria and rules laid down by the Agreements whenever they encounter difficulties in complying with them. If such examination shows non-conformity, they should bring the matter to the notice of the appropriate authorities in their national governments. This will enable their government to raise the matter either bilaterally with the government of the importing country or in WTO forums, with a view to securing modifications in the offending standards or regulations.[72]

6.4 The Law on Standardisation in Different Regions

6.4.1 Standardisation in Mercosur

Known by either its Spanish acronym MERCOSUR, or its Portuguese acronym MERCOSUL, MERCOSUR is a common market made up of the economies of Argentina, Brazil, Paraguay and Uruguay. MERCOSUR's permanent headquarters are in the city of Montevideo, Uruguay.[73] Its principal objectives are to improve the economies of its member countries by making them more efficient and competitive and by enlarging their markets and accelerating their economic development by means of more efficient use of available resources; to preserve the environment; to improve communications; to coordinate macroeconomic policies; to harmonise the different sectors of their economies. In addition to Mercosur, in Latin America there is also an international standardisation body called COPANT or the Pan American Standards Commission. COPANT is a civil, non-profit association. It has complete operational autonomy and unlimited duration. The basic objectives of COPANT are to promote the development of technical standardisation and related activities in its member countries with the aim of promoting industrial, scientific and technological development with the benefit of an exchange of goods and the provision of services, while facilitating cooperation in the intellectual, scientific and social fields. The Commission coordinates the activities of all standardisation institutions in Latin American countries. The Commission develops all types of product standards, standardised test methods, terminology and related matters. The COPANT headquarters are in Buenos Areas, Argentina.

[72] Business Guide, p. 129.
[73] <http://www.jism.gov.jo/english/standardization/standardization.htm>

6.4.2 Standardisation in the USA

The USA perceives the strategic importance of standardisation for global trade. The standardisation process and system in the USA is unique. It does not follow the 'classic' model as seen in and practised by other national standardisation bodies.[74] As seen below, there are various and diverse standardisation bodies providing certification and standardisation. Despite their national character, US standards have to a greater degree been quoted as a basis for global performance. FAA Aircraft safety standards or the Internet Protocol are the only two examples of US standards that have been recognised worldwide as the standards for the safety of aircraft and Internet protocol.[75] The main US national body responsible for the issue of standardisation is the American National Standards Institute (ANSI). ANSI was set up in 1918. Its headquarters are in New York, with a governmental liaison and conformity assessment office in Washington DC'.[76]

ANSI is a private and non-profit organisation. The main functions of ANSI include:

- coordinating the US voluntary consensus standards system;
- approving as American National Standards those standards submitted by standards developers that meet ANSI criteria, and serving as the US member body to the International Organization for Standardization (ISO) and the International Electrotechnical Commission (IEC).[77]

ANSI heads the US private-sector standards federation, and is a membership organisation comprising about 1,300 member companies, 40 federal government agencies, and about 250 professional and trade organisations representing business interests, technical societies, consumer professionals, trade and labour groups, and others interested in American national and international standardisation'.[78] Given the various bodies that deal with standards, an agreement was reached among the American National Standards. They realised that consensus and coordination were needed to deal with standards. In the light of this consensus, ANSI has been trying to ensure that a single body or set of non-conflicting standards are developed and then approved by ANSI-accredited standards developers. Furthermore, the ANSI approval process sees that all interested and concerned parties have the opportunity to participate in the standards-development process and that due process in standards development has been followed. There are about 9,000 ANSI-approved standards today.[79]

[74] OECD, 1999, p. 14.
[75] OECD, 1999, p. 14, especially para. 14.
[76] Steven M. Spivak and F. Cecil Brenner, op.cit., p. 38.
[77] Steven M. Spivak and F. Cecil Brenner, Standardization Essentials: Principles and Practice, New York, Basel: Marcel Dekker, 2001, p. 38.
[78] Steven M. Spivak and F. Cecil Brenner, op.cit., p. 38.
[79] Steven M. Spivak and F. Cecil Brenner, op.cit., p. 38-39.

There is no single and distinct regulation concerning standardisation in the USA. Nevertheless, the US National Technology Transfer and Advancement Act of 1995 does give guidance as to the use of standardisation. This Act, among others, requires the use of voluntary standards in federal technical regulations.

6.4.3 Standardisation in Asia

Each country has its own national standardisation system. The central or most representative national standards body participates within the regional or international bodies.

6.4.3.1 Standardisation in Japan

Japan is one of the few countries in Asia that sees standardisation as one of the central issues for the development of its economic globalisation, technological innovation, and social needs.[80] Standardisation in Japan has its origins in 1922 when the JES (Japanese Engineering Standards) were first set up. 520 JES standards were developed before the Second World War. The main institution that is responsible for the development of standardisation in Japan is the Japanese Industrial Standards Committee (or JISC). JISC was established in 1949, based on the Japanese Industrial Standardisation Law.[81] JISC represents Japan in international standardisation activities, including when it joined ISO in 1952.

Standards in Japan consist of Japanese Industrial Standards (JIS). JIS standards are applied in the industrial sectors. These standards are similar to ISO, IEC, BSI (UK), DIN (Germany), AFNOR (France).[82] They are actually voluntary national standards. From time to time, these standards are established or revised on the basis of a consensus among interested parties, including consumers, producers, academia, etc.[83] Although they are voluntary standards, the Japanese Industrial Standardisation Law does, however, require that technical regulations (law) respect JIS where appropriate. Aoki noted that about 5,000 items in Japanese regulations quote JIS.[84] Japan also pursues its standards system to be in harmony with relevant international standards. This approach is taken on the belief that adopting international standards will not become barriers to trade.[85]

[80] Akira Aoki, International Development and Voluntary National Standardization: Japanese Initiative, manuscript presented at the World trade and Standardization, Berlin: Germany, 2001, p. 2.
[81] Koichi Noda, p. 15.
[82] Koichi Noda, p. 13.
[83] Akira Aoki, op.cit., p. 2.
[84] Akira Aoki, op.cit., p. 2.
[85] Akira Aoki, op.cit., p. 1.

6.4.3.2 Standardisation in Indonesia

The main body responsible for the maintenance and handling of the standardisation issue in Indonesia is the Badan Standardisasi Nasional (abbreviated as 'BSN' or the National Standardisation Body). The BSM was established by Keputusan Presiden (the Presidential Decree) No. 13 of 1997.[86] The main function of BSN is to develop and decide the national standardisation system and guidelines in the field of national standardisation. These systems and guidelines shall become the 'reference' for all activities of standardisation in Indonesia.[87]

The said reference may be voluntary or compulsory standards.[88] It has been reported that as of 2004, there were more than 200 products subject to the compulsory standards.[89] BSN is appointed as the national inquiry point for standardisation issues in Indonesia.[90] It also represents Indonesia in various activities of the international and supranational standardisation bodies. The former includes the International Organization for Standardization (ISO), the Codex Alimentarius Commission (CAC), and the International Electrotechnical Commission (ITC). The latter are, among others, the ASEAN Consultative Committee for Standards and Quality (ACCSQ), APEC Standards and Conformance Sub Committee, Pacific Area Standard Congress (PASC).[91]

In exercising its function, BSN is supported by 2 (two) special committees. Firstly, the Komite Akreditasi Nasional (National Accreditation Committee), whose function is to set up the accreditation and to make recommendations to BSN in setting up and deciding the system of accreditation and certification. Secondly, Komite Standar Nasional Untuk Satuan Ukuran (National Committee on Standard for Measuring Instruments), whose function is to make recommendations to BSN on the national standards for measuring instruments. The law relating to (national) standardisation in Indonesia is Peraturan Pemerintah (Government Regulation) No. 102 of 2000 concerning National Standardisation.[92] The Government Regulation that replaces the previous regulation on standardisation sets out the national standardisation body, the application of Indonesian national standardisation and the sanction for the prohibition products and services that do not meet the national compulsory standards.

[86] By the establishment of BKN, the former standardisation body, namely Dean Standardisasi Nasional (the National Standardisation Council) was abolished.
[87] In its efforts to set up the above system and guidelines, BSN will take into account the suggestions or recommendations provided by the technical parties concerned with standardisation.
[88] Article 2 of the Government Regulation No. 102 of 2000 on National Standardisation.
[89] Kompas, 15 October 2003.
[90] Article 20 para. 2 of the Government Regulation No. 102 of 2000 on National Standardisation.
[91] See: Bambang Supriyo Utomo, Harmonization of International Standards and National Standards,Manuscript, no-date, p. 2.
[92] It is worth noting here that the present legislation on national standardisation, as shown above, is in the form of government regulation, a piece of legislation which under the Indonesian hierarchy of laws, is a level below that of the Law. Given this somewhat weak position, the government is at present drafting a Law on National Standardisation. This Law, if enacted, will make the standardisation issue a more serious and binding piece of legislation within Indonesia territory.

6.4.4 Standardisation in the European Union

The European Union is the regional organisation that pays serious attention to this issue. It has been argued that standardisation has been used as a means for European integration in addition to gaining a competitive position in international trade.[93] Given its strategic importance, the EU has played a key role in setting up international standards. The EU for example, has been a policy maker within the CODEX Commission. As Sara Poli observed: 'EC is also a policy maker within the Codex Commission. Given the importance of Codex standards within the WTO system, EC Codex members are considered crucial in influencing the content of Codex standards. It is in the interests of the European Member States that such standards reflect as much as possible the economic interests and the food policy objectives of the EC.'[94]

The institutions that deal with the issue of standardisation are:
(a) CEN (European Committee for Standardisation)
Founded in 1961, CEN draws up European standards and brings together 18 European standards institutes. CEN has witnessed strong development with the construction of the European Union. Its headquarters are located in Brussels, Belgium. A Technical Board is in charge of the coordination, planning and programming of the work, which is conducted within the work bodies (technical committees, subcommittees, working groups), the secretariats of which are decentralised in the different EU member states. CEN, which includes over 250 technical committees, has published some 2,400 documents, including 2,100 European standards. Over 9,000 documents are under study.[95]

(b) CENELEC (European Committee for Electrotechnical Standardisation)
Founded in 1959 and also located in Brussels, Belgium, CENELEC fulfils the same functions as CEN, but within the electrotechnical sector.

(c) ETSI, European Telecommunications Standards Institute
ETSI develops European standards in the telecommunications field (ETS, European Telecom Standard). Its headquarters are at Sophia Antipolis, France. ETSI brings together 400 members (administrations, operators, research bodies, industrialists, users) representing over 30 countries (EU, EFTA, Eastern Europe).[96] The European Standards established by CEN and CENELEC above are aimed at meeting EU directives (technical regulations). These standards are also intended to transfer the directives into international standards.[97]

[93] Koici Noda, Standardization Policy and Technical Development in Japan, op.cit., p. 35.
[94] Sara Poli, 'The European Community and the Adoption of International Food Standards within the Codex Alimentarius Commission,' 10 European Law Journal (September 2004) p. 167.
[95] <http://www.jism.gov.jo/english/standardization/standardization.htm>
[96] <http://www.jism.gov.jo/english/standardization/standardization.htm>
[97] Koichi Noda, p. 35. [These objectives are supported by the issuing of the European Council Resolution on 28 October 1999. Among other things, this Resolution acknowledges that strong European standardisation has been developed and, secondly, ensures that interests defined at European level be presented coherently in international standardisation).

7 EU Standardisation Policy

7.1 Directives on Patents

The European Patent System is based on two international conventions:
- the Munich Convention on the European Patent Convention (known as EPC) of 1973; and
- the Luxembourg Convention on the Community Patent of 1975.

The Munich Convention of 1973 above is not a Community regime, but only an inter-governmental regime. The ECP Convention established the European Patent Office (EPO) and established a single procedure for granting patents.Through the EPO it is possible within the EU to apply for a so-called European Patent, but this is in essence a bundle of national patents. The application must be filed with the EPO in one of the office's three languages, English, French or German and must designate those countries within Europe where protection is wanted. But, to be legally valid in any particular country, there is a requirement that it should be still be translated into the languages of that country. This requirement laid down in the Luxembourg convention, however, is burdensome.[98]

The requirement to translate the entire patent specifications into each of the official languages of the member states is expensive. The Community patent system, which has not yet been put into operation, would have the advantage of granting patents with a unitary nature. Unlike the European Patent, the Community Patent could be granted, transferred, revoked or allowed to lapse only in respect of the whole of the Union. The other weakness is that the judicial arrangements in place do not guarantee full legal certainty[99]. It is the national courts that adjudicate in cases of dispute. In order to create a Community Patent, the Commission submitted its proposal of 1 August 2000 for a Council Regulation on the Community Patent. 'The draft proposal for a regulation on the Community Patent aims to give inventors the opportunity to obtain a unitary patent which is legally valid throughout the EU.'[100] In addition, on 4 February 1999, the EC submitted its Communication to the Council, the European Parliament and the Economic and Social Committee: Promoting Innovation through patents, the follow-up to the Green Paper on the Community Patent and the Patent System in Europe, the Communication, among others, announced the new legislative initiative covering the patentability of computer programs.[101]

98 <http://europa.eu.itm/comm/internal_market/en/indprop/patent/2k-41.htm>
99 Community Patent and the Patent System in Europe: Green Paper (24 June 1997), p. 1.
100 It should be noted that this dossier is still deadlocked). Community Patent and the Patent System in Europe: Green Paper (24 June 1997), p. 1.
101 It should be noted that this dossier is still deadlocked). Community Patent and the Patent System in Europe: Green Paper (24 June 1997), p. 3.
<http://europa.eu.itm/comm/internal_market/en/indprop/patent/2k-41.htm>

On the above initiative, the EU's executive body submitted the directive, 'patentability of computer-implemented inventions', to the European Parliament, one of the EU's legislative arms, in February 2002. The Parliament, whose members are directly elected, added amendments to the directive that would have barred the patenting of software. However, in May, the EU's other legislative arm, the Council of Ministers, whose members are politicians from EU member states' national governments, narrowly passed its own version of the directive that reintroduced software patenting' [102].

7.2 Directives on Copyrights

The EU directive relating to copyright, namely Directive 2001/29/EC of the European Parliament and of the Council on the Harmonisation of Certain Aspects of Copyright and Related Rights in the Information Society, was adopted on 22 May 2001.[103] It came into full implementation on 22 December 2002.[104] This Directive mainly deals with the protection of copyright and related rights within the internal market of the European Union, with particular emphasis on the information society.

The EU Copyright directive essentially contains the following provisions:
a. reproduction right (Article 2);
b. distribution right (Article 4);
c. right of communication to the public (Article 3);
d. obligations as to technical measures (Article 6).

The Directive grants the exclusive right to the copyright holders to authorise or prohibit direct or indirect, temporary or permanent reproduction by any means and in any form, in whole or in part of their works (for authors); of the phonogram (for phonogram producers); of the first fixations of films (for producers) and of the broadcast (for broadcasting organisations).[105] With regard to the distribution rights, the Directive grants the authors the exclusive rights to authorise or prohibit any form of distribution of the original of their works or of copies to the public for sale or otherwise.[106]

102 <http://europa.eu.itm/comm/internal_market/en/indprop/patent/2k-41.htm>
103 It is worth noting that this Directive 'is based on the principles and rules already laid down in the Directive currently in force in this area, especially Directives 91/250/EEC on the legal protection of computer programs (Directive as amended by Directive 93/98/EEC); Directive 92/100/EEC on rental right and lending right and on certain rights related to copyright in the field of intellectual property; Directive 93/83/EEC on the coordination of certain rules concerning copyright and rights related to copyright applicable to satellite broadcasting and cable retransmission; Directive 93/98/EEC on the harmonisation of the term of protection of copyright and certain related rights; and Directive 96/9/EC on the legal protection of databases. (Preamble of the Directive).
104 Article 13 of the Directive.
105 Article 2 of the Directive.
106 Article 4 of the Directive.

It is worth noting that the last two provisions, namely the right of communication to the public and the legal protection of technical measures, are new features of copyright regulation under the Directive. Article 3 concerning the right of communication to the public grants the authors the exclusive right to authorise or prohibit any communication to the public of their works, by wire or wireless means, including the making available to the public of their works in such a way that members of the public may access them from a place and at a time individually chosen by them'. Article 6 on the obligations as to technical measures obliges member States to 'provide adequate legal protection against the circumvention of any effective technological measures, which the person concerned carries out in the knowledge, or with reasonable grounds, that he or she is pursuing that objective'.

8 Legal Status of Standards Developing Organisations

There is, however, still no uniform legal status governing the standards developed by international organisations. One of the problems arising from the standards developing organisation is the legal status of the IPRs of the said standards. For example, ISO and IEC have common IPR policies (although they do not have an implementation guide for them).

While, on the other hand, ITU-T (ITU Telecommunication Standardisation sector) has developed such guidelines for patent policy.[107] Confronted with of this situation, many companies have been facing the IPR problems in the standards development process in various organisations, especially ISO, IEC and ITU. Various efforts have been made to solve this issue. One of them is the establishment of the World Standards Cooperation (WSC) which was established by ISO, IEC and ITU. The main objective of the establishment of this new organisation is to 'develop policies and strategies on the promotion of international consensus based standards which will be accepted worldwide according to the principle 'one standard, one test - accepted everywhere'.[108]

[107] Recent Development of Discussion on IPR Issues in International Standardization Arena, Sub-Committee on Standards and Conformance, Seoul, Korea, 25-26 February 2005, p. 3.
[108] Recent Development of Discussion on IPR Issues in International Standardization Arena, Sub-Committee on Standards and Conformance, Seoul, Korea, 25-26 February 2005, p. 3.

9 Concluding Remarks

The discussion above demonstrates the close relation between law and standardisation. The role of law will ensure the compliance of standards. Equally importantly, the law will define the legal status of the standardisation. When standards developing organisations consider whether certain standardisation is voluntary or compulsory in nature, it will only be possible to perform this through the law. The efforts made by the WTO in setting up the principles regarding the standardisation should be applauded. Standardisation and its basic principles have been quite supportive, both to developed and developing countries. In this respect, the WTO has just laid down a basic requirement that should be applied by its members so that standardisation does not become an obstacle, especially to international trade.

The law embodied under the WTO Agreement, especially the TRIPs Agreement is also worth noting. Since standardisation is also closely linked to intellectual property rights, the TRIPs Agreement provides a minimum standard and principles regarding intellectual property rights. With this in mind, the TRIPs Agreement provides useful rules and regulations with regard to standardisation, in particular the rules and regulations regarding patents and copyright. The actual and obvious problems with regard to the issue of standardisation are the ability of developing countries to be able to adopt the very basic principle under the WTO Agreement. At the outset, as far as the developing countries are concerned, adopting the internationally accepted standard is still far from easy. The lack of technical and appropriate expertise, coupled with the financial problems that most of these groups of countries face, are the very simple reasons. Secondly, the difficulty of this group of countries to meet the standardisation applied within the developed countries. It has been widely reported that many products from developing countries suffer the consequences of the existence of higher standards imposed by the developed countries.

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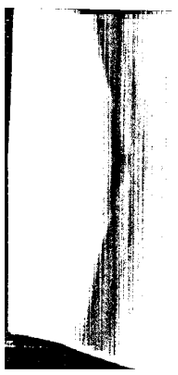
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INTERNET RESOURCES
Note: The links below were seen as of November 2005

European Union: www.europa.eu.int

General Information on WTO, ISO, IEC and World Trade: www.standardsinfo.net

International Chamber of Commerce: www.iccwbo.org

Japanese Industrial Standards Committee: www.jisc.go.jp

ISO (International Organization for Standardization): www.iso.org

World Trade Organization: www.wto.org

11 Glossary

Copyright
'A property right in an original work of authorship (such as a literary, musical, artistic, photographic, or film work) fixed in any tangible medium of expression, giving the holder the exclusive right to reproduce, adopt, distribute, perform, and display the work.' [Black's Law Dictionary, 7th.ed., 1999., p. 337].
See Module: Standardization and International Law
Copyright
An IPR for protecting material such as literary and artistic material, music, films, sound recordings and broadcasts, including software with a technical effect and multimedia. (Clarke, 2004)
See Module: Standardisation and Innovation
Copyrights
Statutory rights granted under the Constitution (law) to an author for a limited time, to control the reproduction or other specific use of an original work of authorship in order to encourage further creative expression (Smoot, 1995).
See Module: External Standardization as a Company Strategy

General Agreement on Tariffs and Trade (GATT)
GATT or General Agreement on Tariffs and Trade is a multiparty international agreement - signed originally in 1948 - that promotes international trade by lowering imports duties and providing equal access to markets. (Henry Campbell Black, Black's Law Dictionary, St Paul: Minn., 7th.ed., 1999, p. 691).

Intellectual Property Rights (IPR)
These include patents, copyrights, trademarks and trade secrets, of which the patents and copyrights are often associated with standards. Thus when standards incorporate technologies that are to be protected, IPR provide a tool for controlling the use of standards.

International Law
The legal principles governing the relationships between nations, more modernly, the law of international relations, embracing not only nations but also such participants as international organizations, multinational corporations, nongovernmental organizations, and even individuals (such as those who invoke their human rights or commit war crimes). (Bryan a. Garner (ed.), Black's Law Dictionary, St Paul: Minn., 7th.ed., 1999, p. 822).

International Standards
Document, established by consensus and approved by an internationally recognised body, that provides for common and repeated use, rules and guidelines or characteristics for activities or their results, aimed at the achievement of the optimum degree of order in a given context. http://www.iso.ch

National Standards
The standard recognised by a national decision to serve as the country's basis for assigning values to other standards of the quantity concerned. See Module: Metrological Measurement
National standard
Standard that is adopted by a national standards body and made available to the public. (EN 45020: 1993) See Module: Development of Standards
National Standards
Documents established by consensus and approved by a recognised national body that provide for common and repeated use; rules and guidelines or characteristics for activities or their results aimed a the achievement of the optimum degree of order in a given context.
See Module: Standardisation and International Law

Patent
'The exclusive right to make, use, or sell an invention for a specified period (usu. 20 years) granted by the federal government to the inventor if the device of the process is novel, useful, and nonobvious.' Bryan A. Garner, Black's Law Dictionary, Second Pocket Dictionary, West Publishing Co., 2001, p. 517 (citing 35 ISCA §§ 101-103).
See Module: Standardisation and International Law Patent
An IPR for inventions such as new and improved products and processes which are capable of industrial application. The patent gives that inventor and/or an applicant the right, for a limited period, to prevent others from making, using or selling an invention without the owner's permission. (Clarke, 2004)

See Module: Standardization and Innovation Patents
Statutory rights granted under constitutional (law) to an inventor for a limited time, for the exclusive use of the invention in order to encourage further invention (Smoot, 1995). External Standardization as a Company Strategy

Sanitary and Phytosanitary Agreement
The Sanitary and Phytosanitary Agreement is one of the agreements and the covered agreements of the WTO that specifically deals with the standards concerning agricultural products. These may include, among others, plants, fruits and vegetables, meat, meat products and other food products. Some countries may require these products to meet sanitary and phytosanitary regulations as well as product standards.

Standards
Standard According to DIN EN 45020 : 1993, a "standard" is a document established by consensus and approved by a recognised body, that provides, for common and repeated use, rules, guidelines or their results, aimed at the achievement of the optimum degree of order in a given context.

Standard Document
This is a document established by consensus and approved by a recognised body, that provides, for common and repeated use, rules, guidelines or characteristics for activities or their results, aimed at achieving the optimum degree of order in a given context (ISO/IEC, 1969b). Unfortunately, not all standards fit into this definition: not all standards are consensus-based or approved by a recognised body and standards may have a format other than a document, e.g. software as in the case of Windows. Therefore, De Vries (1997) has developed another definition: a standard is an approved specification of a limited set of solutions to actual or potential matching problems, prepared for the benefits of the party or parties involved, balancing their needs, and intended and expected to be used repeatedly or continuously, during a certain period, by a substantial number of the parties for whom they are meant.
See Module: Fundamentals of Standards and Standardization

Standardisation
Standardization is the term used to describe a collective process of unification to solve a problem (cf. Kleinemeyer 1996, 27). Standardisation in general describes the "harmonisation and unification of material or procedures for the benefit of those concerned" (cf. Loew von und zu Steinfurth 1986, 879 f.)

Technical Barriers to Trade Agreement
Technical Barriers to Trade Technical regulations and product standards may vary from country to country. Having many different regulations and standards makes life difficult for producers and exporters. If regulations are set arbitrarily, they could be used as an excuse for protectionism. The Agreement

on Technical Barriers to Trade tries to ensure that regulations, standards, testing and certification procedures do not create unnecessary obstacles.
See Module: The European Union and its Standardization Policy

Trade-Related Aspects of Intellectual Property Rights and Counterfeit Goods (TRIPS) Agreement
The Agreement on the Trade-Related Aspects of Intellectual Property Rights and Counterfeit Goods. A multilateral agreement on intellectual property rights concluded during the Uruguay Round negotiations (1986-1994). The TRIPs Agreement is one of the covered agreements under the Agreement Establishing the World Trade Organization.

WTO Agreement
WTO Agreement on Technical Barriers to Trade
A part of the Agreement Establishing the World Trade Organization which aims to ensure that technical regulations, standards, testing and certification procedures do not create unnecessary obstacles to trade, while recognising the right of countries to adopt necessary standards to achieve some level of protection of their legitimate objectives.

12 Key questions

- Explain the relations between standards and law?
- Describe the relationship between standards and intellectual property rights (IPRs)?
- What regimes of the IPRs are relevant to standards?
- Explain the binding force of the standardisation developed by international standard organisations?
- What is the WTO Agreement?
- What is the so-called TBT Agreement under the WTO Agreement?
- What is the so-called SPS Agreement under the WTO Agreement?
- What are the basic requirements laid down by the TBT Agreement in relation to Standardisation?
- Can a member state of the WTO create its own standards different from those laid down by the WTO?
- What is the relationship between the international standards and regional/ supranational standards?

Wilfried Hesser · Axel Czaya

Abstract

This unit deals with the European Union (EU), its institutional attributes, procedures and policies. This subject matter has been selected for the following reasons: the EU not only sets the political framework for the European Standardization System, but also employs it as a policy instrument to complete the Internal Market. A sound knowledge of those attributes of the EU which have an impact on standardization issues is therefore helpful in order to understand the basic attributes exhibited by the European Standardization System. Chapter 3.1 provides a short history of the EU. Chapter 3.2 outlines the institutional status quo of the EU. In Chapter 3.3 current and future policy issues and problems are addressed, such as the European Constitution. Concluding remarks are made in Chapter 4.

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1 Preface

The EU is a 'family' of European countries with similar basic values, political systems and common goals. However, it is neither a loose international organization like the United Nations nor a full scale federation like the USA - it is something 'in between' and exhibits some unique institutional features, as will be seen later. Two main goals that the member states of the EU strive for are peace and prosperity. Prosperity is to be primarily enhanced by the creation of an internal market i.e. the abolition of all kinds of barriers to trade within the EU. This is actually where the standardization issue comes into play: different technical rules, regulations and especially standards repositories in the member states impose such barriers to trade and hamper progress towards a genuine internal market. In order to remove these so-called technical or non-tariff barriers to trade, the EU has adopted a policy which aims at the harmonization of national rules, regulations and standards repositories. This European approach to standardization will be dealt with in the next unit. However, the aims in this unit are twofold: firstly, the unit investigates EU attributes, procedures and policies most relevant to the standardization issue in hand. Secondly, it considers the important present-day policy issues, problems and possible future developments. The basic political questions with regard to the EU are: How far should European integration go, what form should it take, and which political instruments should be applied to reach a specific state of integration? The reader will learn in this respect that grave differences of opinion exist about the final shape the EU should take; multidimensional conflicts are raging among various actors, and the future development of the EU is by no means certain.

Some facts on the European Union

Population:
454,900,000 (ranked 3rd).

Gross Domestic Product:
€10,202,336,800,000 (ranked 2nd).

Area:
3,976,372 km² (ranked 2nd).

The EU is the second largest single market in the world.

The European Union is the largest exporter in the world and the second largest importer.

Figure: Fact sheet on the European Union (Source: www.wikipedia.de)

At the outset, it should be briefly pointed out that the authors have almost exclusively relied on primary sources and media coverage in preparing this unit. This approach was chosen because it provides the most up-to-date snap-shot of the present state of affairs. As changes come very quickly to the EU, even the best secondary literature on this topic has a rather short half-life. Furthermore, the body of secondary literature on the EU comes from various scientific disciplines and is enormous in size. Thus, the use of secondary literature immediately implies not only issues of methodology but also a full scan of a large number of sources - neither of which provides any significant new insight into the standardization issue in hand. Wallace and Wallace and Pollack (2005), Hix (2005) or El-Agraa (2004), however, provide an excellent starting point for those readers who wish to explore the rich body of literature on the European Union.

2 The European Union and its political system

In order to understand the present state of the EU, its policies and its approach to standardization it is helpful to take a look at the historical circumstances which led to the first steps of European integration and the foundation of European institutions. In this section the history of the EU will mainly be told through a history of its treaties. The reasons for this are as follows: firstly, the treaties mark the most important waypoints in the institutional development of the EU. Secondly, a sound understanding of the rather complex structure of the EU treaties is a prerequisite to understanding the EU in general, and thirdly, the treaties provide the foundation on which European standardization policy is built. The system of EU treaties portrayed in this section makes up the 'primary legislation', which is constitutional by nature, specifies basic policies, lays out institutional structures and procedures, and allocates the powers among the EU organs. The primary legislation provides the legal basis for 'secondary legislation' which empowers EU organs to make institutional arrangements among themselves and issue legally binding acts such as regulations and directives, but also decisions, recommendations and opinions (see Section 3.2.2 for details). Consequently, EU law overrides national law in some fields. As will be seen in the following unit, the EU approach to standardization is based on secondary legislation in the first place, whereas standardization issues are rarely addressed directly in the EU treaties.

2.1 A short history of the European Union

After the Second World War, Europe lay in ruins. The war caused unprecedented devastation and such trauma that many European politicians considered ways and means of avoiding such a catastrophe once and for all. Furthermore, Europe had lost most of its military, political and economic might after the war. The USA and the Soviet Union had emerged as the dominating world powers and soon embarked on the Cold War, which to a large extent took place in Europe. This gave rise to considerations of a common European political approach to counterbalance Soviet and US dominance.

2.1.1 Treaty establishing the European Coal and Steel Community

Jean Monnet, a French diplomat, economist and political manager who successfully coordinated allied war production both in World War I and World War II, is widely regarded as the architect of European integration. His plan was to put coal and steel, resources which were especially vital to arms production, under supranational control. To this end, a 'European Community' was to be created which would be given adequate and independent institutions, such as a 'High Authority' and a Court of Justice, vested with adequate powers. Although devised for France and Germany in the first place, the community was to be open to all other European countries willing to join. On 9 May 1950 Robert Schumann, at that time French Minister for Foreign Affairs, made his famous public declaration ('Schumann Declaration') in which he proposed Monnet's plan to create a European Coal and Steel Community (ECSC). Receiving widespread approval, the 'Treaty establishing the European Coal and Steel Community' was drawn up and signed not only by France and Germany but also by Italy, Belgium, Luxembourg and the Netherlands on 18 April 1951 in Paris ('Treaty of Paris'). Jean Monnet was the first to preside over the High Authority. The ECSC ceased to exist 50 years after its ratification on 23 July 2002, as laid down in the Treaty of Paris. Some of its elements were absorbed by the European Community (EC).

2.1.2 Treaty establishing the European Economic Community/ Eurtom (Treaties of Rome)

As the ECSC appeared to be fairly successful, it seemed natural to go for full-scale integration, i.e. to expand the idea of a European Community to the level of politics and defence. But the initiative to set up a European Defence Community (EDC) and a European Political Community (EPC) collapsed during the mid-fifties as the French National Assembly refused to ratify the EDC Treaty. As a result of this setback, activities focused on those fields where common ground was more likely to be reached. Scope for further integration

was identified, especially in the field of economic cooperation. On 25 March 1957 the 'Treaty establishing the European Economic Community' (EEC) was signed by the six founding members. Its aim, among others, was to establish a Common Market, promote 'harmonious development of economic activities', 'continuous and balanced expansion' and 'increased stability'. Core elements of the Common Market were a customs union, the free movement of persons, goods, services and capital, a common agricultural policy and a common transport policy. To carry out these policies, the EEC was provided with an Assembly, a Council, a Commission and a Court of Justice. The EEC Treaty was modified several times, as will be seen later. The Treaty on the European Atomic Energy Community (Euratom) was signed along with the EEC Treaty. Euratom established a common approach to the civil use of nuclear power.
Unlike the EC Treaty, the Euratom Treaty underwent no substantial changes and Euratom will remain a separate legal personality within the EU for the foreseeable future. The Euratom Treaty shall be given no further attention at this point. The EEC Treaty and the Euratom Treaty ('Treaties of Rome') were supplemented by 'A Convention on certain institutions common to the European Communities' which called into being one single Assembly, i.e. the European Parliament, and one single Court of Justice for all communities. The consolidation of European institutions continued in the mid-sixties with the 'Treaty establishing a Single Council and a Single Commission of the European Communities'. Signed on 8 April 1965 and in force since 1 July 1967, the so-called 'Merger Treaty' established one single Commission and one Council of Ministers for all communities. Furthermore, the term 'European Economic Community' was replaced by the term 'European Community'. With the Merger Treaty, the core institutions of the European Community were set up. Commission, Parliament and Council of the European Communities, as it was called from then on, span the so-called 'Institutional Triangle', which drafts and adopts European policy initiatives.

2.1.3 The nineteen-seventies and the early nineteen-eighties

In the nineteen-seventies the European Parliament was endowed with additional responsibilities: The 'Budgetary Treaties' of 22 April 1970 and 22 July 1975 ('Treaty amending Certain Budgetary Provisions of the Treaties establishing the European Communities and of the Treaty establishing a Single Council and a Single Commission of the European Communities' and the 'Treaty amending Certain Financial Provisions of the Treaty establishing the European Communities and of the Treaty establishing a Single Council and a Single Commission of the European Communities') granted the Parliament additional responsibilities in budgetary affairs. On the basis of 'Decision 76/787/ECSC, EEC, Euratom relating to the act concerning election of the representatives of the Assembly by direct universal suffrage' of 8 September 1976, the first direct elections to the

European Parliament were held in 1979. Until this election the European Parliament was made up of members of the national European parliaments.

2.1.4 Stagnation in the late seventies

In the late seventies decision-making on the European level was hampered mainly for the following reasons:
- The United Kingdom and Denmark, two rather eurosceptic countries, joined the EC together with Ireland.
- Since the so called 'Luxemburg Compromise' of 1967 unanimity was still the prevailing decision-making mechanism especially in the council and no steps had been taken towards introducing majority voting procedures.
- The oil shock of 1973 and the subsequent economic crisis in the western world revived protectionism on the national level.

As a result, political decision-making increasingly shifted away from the European level to the national level in the late seventies. In the early eighties, however, Japan and the USA made tremendous technological and economic progress. The prospect of falling behind in these fields led to some political initiatives being revitalized on the European level.

2.1.5 Single European Act

The 'Solemn Declaration on European Union' of June of 1983 the European Council, i.e. the summit of the heads of the EC member states, agreed to make further steps towards European integration. The 'Single European Act' (SEA) of 17 February 1986 laid down the political programme for the coming years.
The SEA amended the founding treaties and encompassed the following elements (among others):
- The plan was laid down to create a European Union and to establish a single internal market, to be completed by the end of 1992. (In the SEA, the term 'internal market' replaced the term 'common market'.)
- Qualified majority voting procedures replaced unanimity in various policy areas.
- In a step towards more direct democracy, a 'cooperation procedure' was introduced which granted the European Parliament greater influence in decision-making (see 3.2.4).
- Some new policy fields were opened up which had not been addressed in the founding treaties. Among those policy fields are the protection of the environment, research & technology and also social and regional policies.
- The European Council was institutionalized.
- The European Monetary System was to be reinforced.
- European co-operation in the field of foreign policy was to be intensified.

In general, the SEA was aimed at closer co-ordination of various policies, the completion of the internal market and the enhancement of international competitiveness - not least through technical harmonization. In Article 118a - which supplements the Treaty of Rome - this was explicitly addressed. The SEA implied a significant step towards supra-nationalization and increased European integration. Furthermore, the European Communities moved forward into new policy areas. Additionally, an ambitious time schedule was introduced to complete the internal market and create a European Union.

2.1.6 Maastricht Treaty

The Treaty on European Union ('Maastricht Treaty') was signed on 7 February 1992 in Maastricht, came into power on 1 November 1993 and implied an additional major revision of the founding treaties only five years after the SEA had come into effect. The reasons for such a comparatively fast and far-reaching action were among others:

- The project of the internal market spilled over to other policy areas and created a demand for action on a much wider scale. The main element of the Maastricht Treaty was the plan to establish a monetary union at the beginning of the next century. High on the agenda were also social policy issues, as well as some side-effects of an internal market, such as immigration, cross-border criminality and social dumping.
- The first signs of globalization had already appeared on the horizon in the early nineteen-nineties.
- After the collapse of the Soviet Union and Soviet-style socialism many Central and east European countries were eager to join the west European political sphere. The European Communities provided an ideal platform for the integration of those countries and enjoyed a tremendous boost in popularity.
- In view of the new political situation in Europe, a common European approach to foreign affairs was considered helpful by many politicians.
- With the prospect of many new countries joining the EC in the foreseeable future, a realignment of decision-making procedures appeared to be necessary.
- Last but not least, many politicians considered European integration a suitable way to 'incorporate' a reunified Germany.

The Maastricht Treaty called into existence the European Union and introduced under its roof the 'Three-Pillar Structure':

- The 'European Community Pillar' which comprises the three Communities.
- The 'Common Foreign Security Policy Pillar' (CFSP Pillar).
- The 'Justice and Home Affairs Pillar' (JHA Pillar).

Most of the supra-national elements of the European Union have been subsumed under the Community Pillar in the Maastricht Treaty, whereas the

Three-pillar structure of the EU



Figure: Three-pillar structure of the EU (Source: www.wikipedia.de)

so-called 'intergovernmental' elements, which provide a larger degree of national autonomy, are by and large allocated to the CFSP and JHA Pillars. The following modifications were made to the European Community Pillar (among others):

- A citizenship of the Union was introduced.
- As laid down in the SEA, qualified majority voting procedures and the co-operation procedure were introduced in various policy areas.
- A 'Committee of Regions' was created.
- The way was paved for a European Economic and Monetary Union and the euro in particular, as mentioned above.
- A common policy in various areas was agreed upon (see Article 3 EC Treaty).

2.1.7 Treaty of Amsterdam

The 'Treaty of Amsterdam' amending the Treaty of the European Union, the Treaties establishing the European Communities and Certain Related Acts was signed on 2 October 1997 and came into force on 1 May 1999. It had a rather minor impact on technical harmonization and standardization (albeit a significant impact in other policy areas) and shall thus be mentioned only in passing.

2.1.8 Lisbon Agenda

The Lisbon Agenda is an action plan devised to tackle the challenges of the first decade in the new millennium and bears some relevance for the standardization issue in hand, as will be seen in the module European Standardization Policy. Agreed upon by the European Council in a special meeting in Lisbon on 23-24 March 2000, its ambitious aim is to make the EU 'the most competitive and dynamic knowledge-driven economy by 2010, capable of sustainable economic growth with more and better jobs and greater social cohesion'. The Lisbon Agenda focuses on issues like the knowledge-driven economy, research and innovation, the creation of the information society, the modernization of social welfare and education systems, the completion of the internal market, the creation of a business-friendly environment especially for innovative start-ups, and many more. In many of the above-mentioned issues standardization basically plays a significant role. And indeed, although not explicitly mentioned in the Presidency Conclusion (where the Lisbon Agenda is laid down), standardization is indirectly given a significant role in the Lisbon Agenda. European Stan-dards Bodies play for instance an active role in the creation of 'eEurope'), as will be seen later. The Lisbon Agenda is laid down in the Presidency Conclusions. For a summary of the Lisbon Agenda, see 'Employment, Economic Reform and Social Cohesion towards a Europe of Innovation and Knowledge'.

2.1.9 Treaty of Nice

The Treaty of Nice, which was signed on 26 February 2001, was in the first place devised to realign EU institutions with regard to the upcoming enlargement and brought several modifications to the existing treaties. Similar to the Treaty of Amsterdam, the Treaty of Nice had no immediate impact on European standardization.

2.1.10 Treaty establishing a Constitution for Europe

The Treaty of Nice drew criticism from many quarters as it failed to deliver on substantial and urgent changes to the existing treaties. The three-pillar structure, for instance, was regarded as far too complicated by many critics. European institutions still appear much too obscure and abstract to win the hearts and minds of European citizens (Kassim 2003, 140, and Nakamura, 11). The treaty has actually failed to satisfy both eurosceptics and pro-Europeans: for eurosceptics the Treaty of Nice goes much too far with integration, whereas for pro-Europeans the Treaty stops short of making the necessary steps to deeper integration. However, some of these shortcomings, along with the need for further discussions and actions, were already identified in the Treaty of Nice (Annex 23: Declaration on the future of the Union). Issues to be addressed were the delimitation of powers between the European Union and the Member States, the Charter of Fundamental Rights of the European Union, simplification of the treaties and the role of the national parliaments in the EU. Following the Laeken Declaration, which was concluded at the Laeken European Council on 14-15 December 2001 and requested the EU to be 'more democratic, more transparent and more efficient', the European Convention (also called Convention on the Future of Europe) was established. The Convention had its inaugural meeting in February 2002, was chaired by former French president Valéry Giscard d'Estaing and comprised representatives from the governments of the member states, national parliaments, the European Parliament and the Commission. Accession candidate countries were represented in the same way as the member states but had no veto rights on decisions of the Convention. The Convention came up with a draft constitution on July 2003. In October 2003 an Intergovernmental Conference started work on finalizing the convention. Despite difficult negations, agreement on a final version was eventually reached in June 2004. The constitutional treaty - a document of no less than 485 pages - was finally signed in Rome on 29 October 2004 and is currently going through the ratification process. As this brief history of the EU slowly but surely catches up with the present day, it is worthwhile to take a look at the present state of EU institutions (Section 3.2) and then come back to the Constitution (Section 3.3), which is presently going through the ratification process, and to consider the changes that it is due to bring to EU institutions.

2.2 The institutional status quo of the European Union

In order to pursue common goals and policy issues of common interest, member states called into being common European institutions, such as the Commission and the European Parliament, vested them with (more or less) adequate powers and furnished them with a considerable degree of national sovereignty. Many of these institutions have already been mentioned, but with no details of their institutional attributes, i.e. their rights and obligations within the EU nor their relations towards other institutions and organs. This section mainly gives such details for those institutions that are especially relevant for European standardization policy. The shift of power from member states to the EU level, the carrying out of EU policies and the subsequent convergence of living conditions in the EU is usually called 'European integration'. The reader will learn that the European institutions described in this section exhibit some unique features. Interest, however, will focus on those institutions that are most relevant for the issue of standardization. These are primarily the previously mentioned 'Institutional Triangle' of European Parliament, the Commission and the Council of the European Union.
Section 3.2 provides pure information on European institutions and organs. A critical assessment is given in Section 3.3.

2.2.1 The European Parliament

The European Parliament performs the following tasks within the EU structures:

Legislation:

- Jointly with the Council, it exercises the power to legislate. The Parliament actively takes part in the codecision procedure which gives the Parliament and Council equal rights in many legislative matters (Article 251 (ex Article 189b) of the EC Treaty).
- In some important political or institutional issues, like the appointment of a new Commission, the Parliament's approval is required.
- The Parliament may ask the Commission to come forward with proposals for new laws.

Supervision:

- The Parliament supervises other EU institutions, especially the Commission. The Parliament has the right to interview and reject newly appointed members of the Commission (as happened recently in 2004).
- The Commission is furthermore held politically accountable and can be forced by the Parliament in a so-called "motion of censure" to resign as a whole.
- Usually, however, exchange of information takes place in the form of reports which the Commission sends to the Parliament. MEPs frequently ask the Commission oral or written questions.
- The Parliament also closely cooperates with the Council in such areas as foreign and security policy, judicial co-operation or fraud and international crime.

Budgetary issues:

- The Parliament decides jointly with the Council on the annual EU budget.
- It has the right to approve the budget for the previous financial year, i.e. the Commission's handling of it.

The European Parliament exhibits the following institutional attributes (among others):

- Members of the European Parliament (MEPs) are not grouped in nations but belong to European parties which represent the whole political spectrum in the member states.
- Presently, the EP is made up of 732 MEPs. After the next enlargement in 2007 the EP will be made up of 786 MEPs
- Since 1979 the Parliament has been directly elected by the EU citizens every five years.
- Decisions are made in plenary sessions.

It should be pointed out that the Parliament's responsibilities and powers have consistently been strengthened with each modification of the founding treaties.

2.2.2 The Council of the European Union

The Council of the European Union (or simply 'Council') has the following responsibilities:

- It has the power to legislate - in many cases jointly with the Parliament. The Council only becomes active on a proposal submitted by the Commission .
- It approves the EU budget - again jointly with the European Parliament, which nevertheless has the last say in budgetary issues.
- The Council coordinates the economic policies of the member states.
- It has the right to conclude agreements on the international level on behalf of the EU.
- The Council sets out guidelines on the Common Foreign and Security Policy.
- It acts as a coordinator in the field of Justice and Home Affairs.

The Council is the highest decision-making body within the EU. Depending on the agenda, be it foreign affairs or farming, the Council meetings are attended by the respective ministers, i.e. the composition of the Council varies according to the political issue under consideration. If, for instance, economic and financial issues are on the agenda, it will usually be the finance ministers (or their proxies) who meet ('Economic and Financial Affairs Council', ECOFIN). The Council concludes the following legal acts: regulations, directives, decisions, common actions, common positions, recommendations and opinions (see Article 249 (ex Article 189) EEC Treaty). Both regulations and directives are

legally binding for the member states. Directives are not only legally binding but have to be converted into national law. European Directives are the preferred legal instruments in the case of standardization policy, as will be seen later. Qualified Majority Voting has steadily been expanding and is presently the common voting procedure in most cases. In sensitive policy fields, however, unanimity still prevails. Presidency of the Council rotates every six months. The Council is supported by a General Secretariat. The Secretary-General, who at the time of writing in December 2005 is Javier Solana, is also 'High Representative for the Common Foreign and Security Policy'. Meetings of the Council are prepared by the 'Committee of Permanent Representatives of the Member States' (COREPER, 'Comité des représentants permanents'), an influential body with substantial agenda-setting powers.

2.2.3 The Commission of the European Union

The Commission is the 'driving force' in the EU and has the following tasks and responsibilities:

- It proposes legislation to the Parliament and the Council ('right of initiative').
- It implements and manages EU policies and the budget.
- The Commission is frequently called the 'Guardian of the Treaties' and enforces European law (in cooperation with the Court of Justice).
- The Commission represents the EU on the international stage.

The Commission has wide-ranging powers for agenda-setting within the EU. It is the Commission in the first place that proposes new EU laws whereas the Parliament and the Council of the European Union adopt (or reject) these proposals. Whenever the Commission perceives a need for new EU legislation, it drafts a proposal and submits it to the Parliament and the Council. In drawing up its proposals, the Commission closely cooperates with various EU organs - especially the Economic and Social Committee and the Committee of the Regions (see Sections 3.2.6 and 3.2.7), but also actors on the national level such as parliaments and governments. The Commission is supported by administrative bodies, the so-called 'Directorates-General' (DGs) and 'Services'. In the Directorates, the policy initiatives are conceived and prepared by experts for each policy area. The European standardization approach is for instance devised and managed under the auspices of the Enterprise Directorate-General. As far as the issue of standardization is concerned, the Commission is the most relevant political actor. In general, the Directorates are the institutional loci where experts draft legislation, generate policies, ideas and initiatives. A new Commission is appointed every five years (after the European Parliament has been elected): firstly, the member states agree (unanimously) on the new Commission President. Secondly, in close cooperation with the member states, the designated President selects suitable new members to join the Commission.

Thirdly, the Parliament interviews all candidates and may reject candidates, if this appears to be necessary. The President has to propose new candidates under these circumstances. Presently, the commission is made up of 25 members - one per country.

2.2.4 The codecision procedure

A closer look at the codecision procedure (CDP) is worthwhile for a number of reasons: the CDP firstly defines the interrelations between Commission, Parliament and Council in the process of legislative decision-making and provides a nice example of how decisions are made within the EU system. The CDP acts as the 'institutional glue' which holds together the Institutional Triangle. Furthermore, the CDP is the decision-making procedure of choice that already applies to a large number of policy areas and especially to the field of standardization. However, it would be going too far at this point to consider every detail of the CDP or other decision-making procedures applied by EU organs. Some basic facts on the codecision procedure: the CDP was introduced with the Maastricht Treaty, as already mentioned in Section 3.1.6. It is laid down in Article 251 (ex Article 189b) of the EC Treaty. Presently, the CDP applies to 43 policy areas under the first EU pillar. From 1999 to 2004, 418 CDPs reached completion, while two procedures failed to do so.

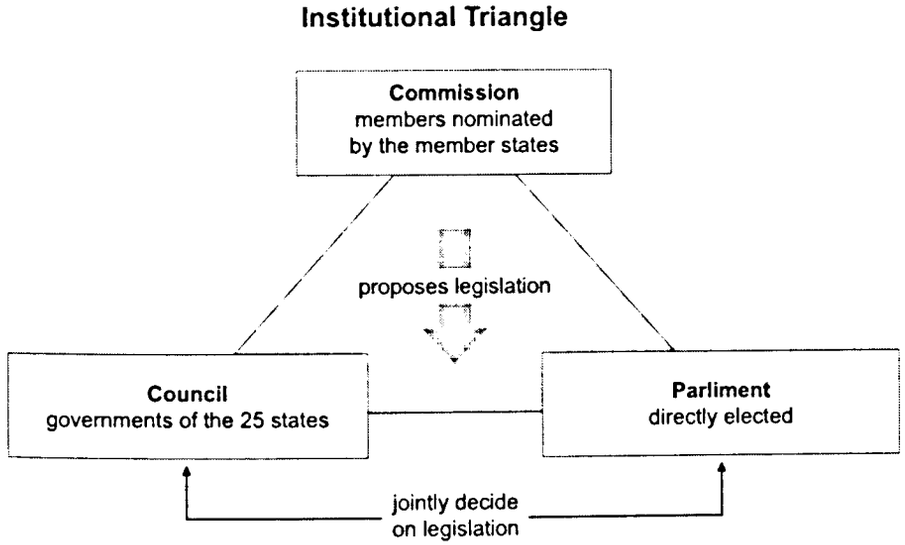


Figure: Institutional Triangle (Source: bbc.co.uk)

In principle, the CDP implies an increase in democracy because the Parliament is given equal rights to the Council to decide (i.e. 'co-decide') on the draft legislation submitted by the Commission.

The CDP works in the following way:

1. After consultations with various actors (e.g. experts, relevant organizations and parties affected), internal evaluations and discussions, and after consulting the Committee of the Regions and the Economic and Social Committee (see 3.2.8 and 3.2.9), the Commission submits a legal proposal to the Council and Parliament.

2. In a first reading (and after internal consultations in the relevant parliamentary committee,) the Parliament decides on an opinion by simple majority in a plenary session. Without any explicit time lines being set, this takes eight months on average.

3. The Commission may alter its legal proposal according to amendments stipulated by the Parliament (Article 250(2) of the EC Treaty).

4. Simultaneously with the Parliament, the Council prepares in its first reading a position on the Commission's proposal. The Council may accept the Commission's proposal without changes, may accept the version supplemented with the European Parliament's amendments, or may issue a Common Position, should it hold views other than those of the Commission or the Parliament (Article 251(2) of the EC Treaty).

After approval by the Council, the proposal is submitted for signature to the Presidents and Secretaries-General of the European Parliament and the Council. The procedure ends with the publication of the legal act in the Official Journal. It should be noted that this is merely a sketch of the CDP. The procedure may be cut short, should Parliament and Council immediately agree on the Commission's proposal. On the other hand, provisions do exist to deal with cases where opinions on a legal act differ substantially. Both the Parliament and the Council may go into a second reading. If necessary, a Conciliation Committee steps into action in order to reconcile the different opinions. The CDP may, however, come to an end without a legal act being adopted should all efforts to reach a compromise fail. A look at the CDP flow chart immediately highlights its complexity. The track record on the other hand (418 successful and only two uncompleted procedures from 1999 to 2004) suggests that the CDP works rather fluently in practice. The CDP additionally opens up scope for 'obstructive behaviour' within the Institutional Triangle. The Parliament might for instance permanently reject proposals made by the Commission. In the 'Joint Declaration of 4 May 1999 on practical arrangements for the new codecision procedure', Commission, Parliament and Council agreed to co-operate in good faith and in a constructive manner. The problem of complexity was addressed in the 'Interinstitutional agreement on better law-making' of 31 December 2003.

Flow chart of co-decision procedure

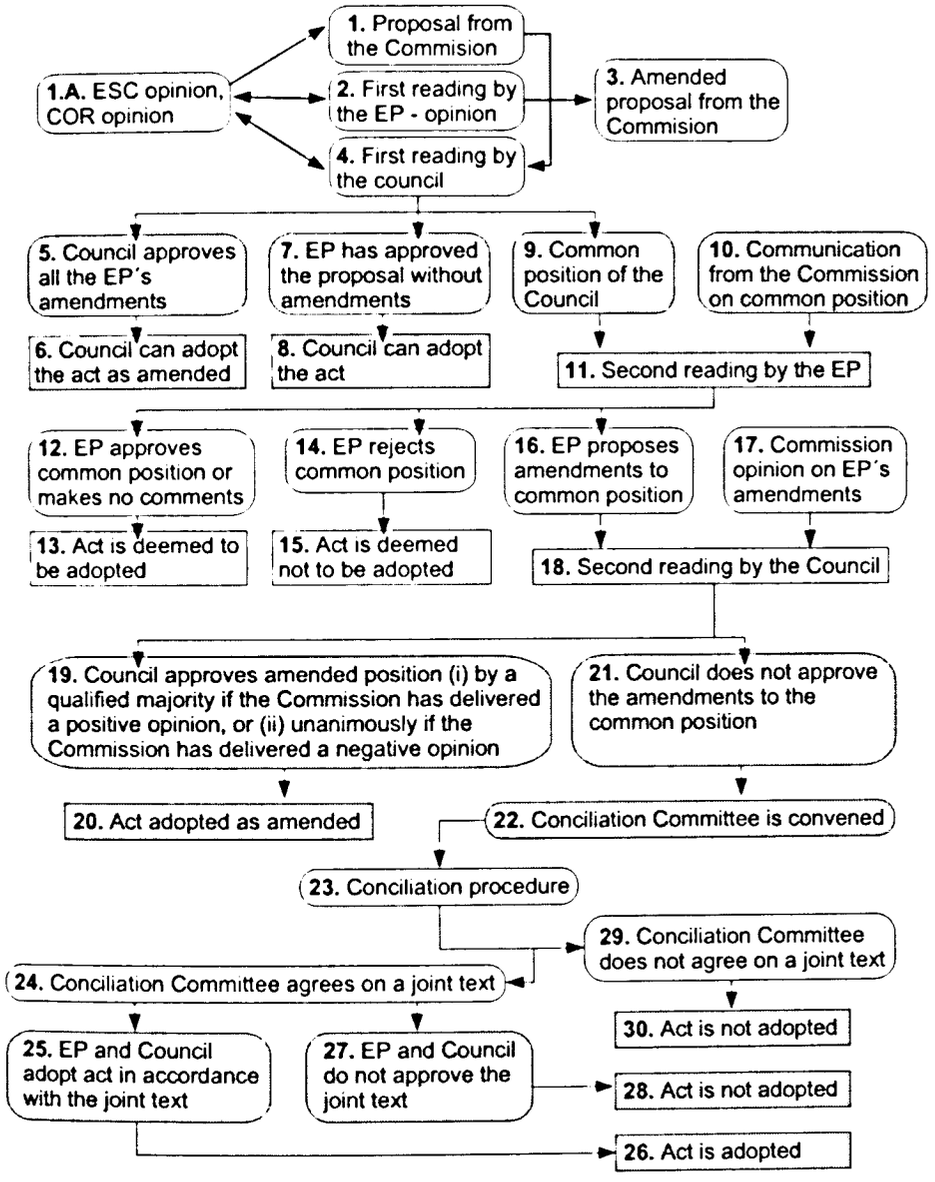


Figure: Flow chart of co-decision procedure (Source: ec.europa.eu.int)

2.2.5 The European Council

The term 'European Council' simply applies to the regular meetings held by the leaders of the EU member states (assisted by the Ministers for Foreign Affairs) and the President of the Commission. Held on an occasional basis since the mid-seventies, these meetings were institutionalized in the Single European Act and now take place four times per year. The European Council makes the far-reaching decisions on the path European integration should take. The European Council issues guidelines, sets priorities for EU institutions - usually in the form of declarations or resolutions. The European Council provides the 'grand visions' on the future of the EU. The European Council is frequently confused with the Council of the European Union and the 'Council of Europe', an international organization which is not directly related to EU institutions. The Council of Europe is engaged in educational, cultural and human rights issues.

2.2.6 Court of Justice

The Court of Justice ensures that Community law is applied equally in each member state. National courts may occasionally have problems in correctly interpreting Community Law. In such cases, a national court approaches the Court of Justice and asks for advice. This advice is handed down as a 'preliminary ruling'. Based on Community Law, the Court is also entitled to settle legal disputes between EU institutions, companies and individuals. Each member state provides one judge at present but, even after the next enlargement, 11 judges will suffice to constitute the 'Grand Chamber'. The Court is supported by eight 'advocates-general', who publicly and impartially present their opinions on the cases in hand. Both judges and advocates-general are appointed by joint agreement of the governments of the member states for a six-year term. In order to cope with numerous legal cases, a 'Court of First Instance' was installed in 1989. The Court of Justice usually steps into action if:

- Community law is interpreted and applied differently in different member states.
- A member state fails to fulfil its obligations.
- A specific EU law is considered to be illegal by some member states, the Council or the Commission.
- The Parliament, the Council or the Commission fails in its obligation to make certain decisions.

As will be shown later, the Court of Justice made some decisions which actually modified both the interpretation of the treaties and the scope of action for EU organs. On the (partly complex) judicial system of the EU see for example Sweet (2004).

2.2.7 Intergovernmental Conferences

Intergovernmental Conferences (IGCs) have already been mentioned frequently. They are held by the governments of the member states and usually deal with the amendment of EU Treaties. Consequently, far-reaching decisions are made in IGCs, e.g. on the modification of EU institutions, the restructuring of the treaties or the future general course of future development in the EU. All major modifications of the Founding Treaties have been accompanied by IGCs.

2.2.8 European Economic and Social Committee

The European Economic and Social Committee (EESC) is an advisory body and represents various stakeholders and interest groups, such as employers, trade unions, farmers and consumers, i.e. social groups which actually constitute the 'civil society' in Europe. The Committee issues opinions on various issues and has to be consulted whenever decisions on economic and social issues are being made. It also occasionally has a say in the issue of standardization.

2.3 Policy issues and problems the EU faces

This section addresses the most important current policy issues, problems and possible future developments in the EU. How the EU will evolve in the future is by no means certain. The road to European integration has been rocky at times. There have been remarkable success stories but also situations of crisis, scandal, stagnation and failed policy initiatives. Furthermore, grave differences exist among various actors as to what the final shape of the EU should be. At the heart of the debate is the question of how far European integration should go and what form it should take. The European Constitution for instance, which is presently going through the process of approval in the member states, is hailed by some as a decisive step towards a European federation, whereas others merely call it a 'clean-up operation' which consolidates the far too complex system of EU treaties. The following section will firstly address some general issues and problems. Secondly, it will take a brief look at one of the most prominent policy issues, EU enlargement and foreign affairs. Thirdly, it will revisit and discuss the EU Constitution - devised to address at least some of the problems and issues.

2.3.1 General issues and problems

The basic political questions are clearly stated once again: how far should European integration go, what form should it take, and which political instruments should be applied to reach a specific state of integration? In principle two extreme settings are conceivable:

- The non-existence of any supranational structure, i.e. total independence/ sovereignty of European states.
- A fully integrated federation with an overridingly powerful supranational structure ('superstate') which allocates only minimum competences to the member states.

In between these two extremes there is a continuum of different institutional states, which exhibit varying degrees of integration. And of course, different actors hold different opinions or preferences about the final shape the EU should take. These preferences are based on fundamental beliefs about how societies should be organized and how states should coordinate their activities in specific policy areas. Preferences may also depend on (possibly biased or incomplete) information, education and socialization, and not least on the track record the EU has to offer in general.
It should come as no surprise that preferences among European citizens and politicians are distributed across the whole spectrum of institutional states: at one end of the spectrum it is therefore possible to find pro-Europeans or europhiles, who unreservedly advocate full-scale integration, whereas at the other end are the europhobes, who would rather immediately do away with the EU as a whole. In between these two extremes there is a variety of euro-realists, euro-critics or eurosceptics. This section takes a rather critical view and examines the deficiencies and shortcomings exhibited by the EU, some of which are indeed serious. Even the strongest pro-European advocates would find it difficult to deny this fact. They simply draw different conclusions on the EU and its future shape than would a staunch Europhobe.

A few examples of the deficiencies that plague the EU are given below:

Democratic deficit, lack of transparency
Many EU institutions and procedures do not meet democratic standards and lack transparency, as critics argue. The mode in which, for instance, the commission is appointed is far from being democratic and more of an example of obscure backdoor policy. From the outset, European integration was a project of a remote political elite which failed to win the hearts and minds of its citizens. The common EU citizen barely understands what is being done why, how and by whom within the complex and faceless system of EU institutions. See e.g. Majone (1998) on that issue.

Political conflicts of various kinds
The EU is not always the harmonious 'family' of nations it purports to be. On the contrary, political conflicts of various kinds between various actors frequently break out on the EU stage. Coalitions may change rapidly. National interests very often prevail over common interest. The interests of small and large member states are frequently at odds. Adopted in June 1997, the Stability and Growth Pact, for example, has successfully been watered down recently by the big member states France and Germany, who repeatedly failed to meet budget deficit thresholds. This embittered those small member countries that had made strong efforts to meet the stability and growth criteria. Ironically, it was Germany who so strongly endorsed the creation of a Stability and Growth Pact in the nineteen-nineties. EU policy initiatives may face stiff resistance from member states. A recent example has been the notorious "Service Directive" which expands the EU harmonization approach from goods to services. The directive opens up the scope for misuse and fraud, as some member states and especially unions argued. Countries like France and Germany, in particular, fear the influx of cheap services and labour from poorer EU member states. The Service Directive was handed back to the Commission for revision and will (presumably not before 2009) come into force in a modified version.

Failed policy initiatives
Some ambitious initiatives eventually failed to succeed or were silently buried. In November 2004, for example, the 'Kok report' assessed the achievements with regard to the Lisbon Agenda. ('Facing the Challenge: The Lisbon strategy for growth and employment'; Report from the High Level Group chaired by Wim Kok, November 2004, http://europa.int) Too many targets have been seriously missed and too many promises have failed, the report concluded, and Romano Prodi, at that time Commission President, declared the plan to create 'the most competitive and dynamic knowledge-driven economy by 2010' a failure. Inspired by the Kok report, the Barroso Commission took measures to give the Lisbon Agenda new impetus. See for example Commission (2005b).

Euro-sceptical parties in the European Parliament
In accordance with basic democratic principles the European Parliament is open to euro sceptical parties, e.g. the UK Independence Party or the Junilistan ('June List') Party from Sweden. These parties - although eurosceptical for different reasons and to different degrees - might try to topple the system from within. Euro sceptical Members of the Parliament formed the Independence/ Democracy Group in 2004, which for instance opposes the European Constitution. In the last election some rather grotesque figures, such as a Czech porn queen, ran for election to the EP. Responsible behaviour and policy-making can hardly be expected from those quarters.

Typical arguments put forward by eurosceptics and europhiles

A eurosceptic may typically put forward the following arguments against the EU:

- Eurocrats are trying to create a centralized European superstate which significantly impairs the sovereignty not only of my home country but also of all other member states.
- Economic cooperation: yes (or maybe); political integration: no.
- I can neither identify with EU institutions nor their policies.
- A highly overpaid, complex, remote and corrupt bureaucratic apparatus issues absurd laws, rules and regulations which interfere with my way of life.
- Living conditions in the member states are standardized by the EU. Consequently, identities are being lost.
- The EU fails to deliver on its promises. Many if not all policy initiatives have failed.
- My home country would fare better in any respect without an EU membership.
-

A europhile would argue (and reply):

- When assessing the EU, one should go beyond pragmatic cost-benefit-analysis and take 'higher values' into account. The EU has brought long-lasting peace, stability and prosperity to Europe.
- In an evolving multi-polar world, close European cooperation in all policy areas is a necessity.
- There are of course problems and deficiencies, but these can be solved by appropriate arrangements and even closer cooperation.
- Given the principle of subsidiarity, national and regional identities are not compromised or eliminated by European integration but instead supplemented by a European identity.
- There are indeed success stories. How about the successful maiden flight of the Airbus A380? This is an outstanding example of what European cooperation can achieve.

One basic problem for the EU is that almost every policy initiative draws criticism from both extremist camps: for eurosceptics, a given policy initiative is usually another fatal step towards a European superstate, whereas for europhiles, the same step does not go far enough in creating a European federation. Every modification of the founding treaties implied a transfer of powers from the national to the European level and a further step towards integration. The so-called 'Acquis Communautaire', i.e. the body of (primary and secondary) EU legislation which has irreversibly been built up so far, expands to a long list of policy areas. In the meantime, the EU has a say in almost every field. In this respect eurosceptics have been more on the retreat.

2.3.2 Enlargement

EU enlargement is presently one of the major policy issues in Europe and will therefore be given due attention. The sequence of EU enlargements has been as follows (see the history of the European Union:

- 1973: The United Kingdom, Ireland and Denmark join the EC.
- 1981: Greece joins.
- 1986: Spain and Portugal join.
- 1990: East Germany and West Germany are reunified, increasing the Union's area and population, but not the number of member states.
- 1995: Austria, Sweden and Finland join the European Union.
- 2004: In the biggest single enlargement, Cyprus, the Czech Republic, Estonia, Hungary, Latvia, Lithuania, Malta, Poland, Slovakia and Slovenia join.
- 2007: Romania and Bulgaria join.

The last enlargement, in particular, was of historic proportions and has brought fundamental changes to the EU. The Treaty of Accession was signed by the Heads of State at a ceremony on 16 April 2003 in Athens and entered into force on 1 May 2004. With the number of member states jumping by 10 to 25, realignment became especially necessary in decision-making procedures. Issues of standardization played an especially important role with regard to the enlargement of 2004. East european accession states had to transform their repositories of GOST standards - a legacy of the former Soviet Union/Council for Mutual Economic Assistance (COMECON) - into a modern, EU-compatible standards repository. Not least thanks to the active support of European standards bodies and national standards bodies, this transformation was successfully accomplished in very short time. EU enlargement will nevertheless continue. Bulgaria and Romania joined the EU in 2007 after the European Parliament gave its blessing in April 2005. Accession is being negotiated with Croatia and Turkey and many more countries are ready to apply for membership.

Enlargement imposes a number of problems for decision making-procedures (Hosli and van Deemen (2002)). In principle, the more actors involved, the higher the cost of decision-making (in terms of time consumed to reach a decision): the more member states, the higher the risk that interests will substantially differ on various subjects and the harder it will be to reach decisions based on unanimity. Consensus-building among six rather homogeneous West-European countries was probably much easier in the nineteen-sixties than today among 25 states that are scattered over the whole map of Europe. In view of the forthcoming enlargement, it will for instance be increasingly difficult to grant all member states equal rights in and equal access to the Commission without compromising the latter's ability to perform its tasks.

Enlargement of 1 May 2004

Number of member states increased from 15 to 25.

EU population inreased by more than 80 million from 370 million to over 450 million.

Number of working languages increased from 11 to 20

Number of SMEs increased from 19 million to 22 million.

New members represent 20 per cent of the existing EU population but only 5 per cent of the actual gross domestic product (GDP).

Figure: EU enlargement 1 (Source: http://ec.europa.eu)

2.3.3 The European Constitution revisited

As already indicated in Section 3.1.10, the European Constitution is designed to address at least some of the problems described in the preceding sections. The Constitution is a hard-won compromise between Federalists and Intergovernmentalists that brings changes that are more incremental than revolutionary to the existing treaties (see Abromeit, H. and Wolf, S. (2005) and Kiljunen, K. (2004) for an assessment):

- First of all, the Constitution consolidates the existing complex set of EU Treaties into one single document.
- Clause 5, Article I-3 ('The Union's objectives') restricts the powers of the EU to those fields the member states have explicitly agreed upon. This clause shall prevent EU organs from the much-criticized practice of 'seizing' policy fields not explicitly specified in the EU treaties.
- The EU is nevertheless granted new rights in additional policy fields such justice (see Title III, Union competences).
- The rather fragmented three-pillar structure, along with its separation of supranational and intergovernmental policy fields, will be absorbed under the EU umbrella.
- For the first time the Union will have legal personality. Without a legal personality the EU has been unable to conduct foreign policies on its own behalf and enter into international agreements for example. (Presently, only the European Community has a legal personality.)
- A new mode of Qualified Majority Voting will be introduced in all fields except for foreign policy, defence and taxation. This rather complicated voting procedure (see Article I-25 for details) has been devised to provide a better balance of interests between small member states and large member states.
- Although the Union is granted the 'competence to define and implement a common foreign and security policy', each member state can veto decisions and act independently in these policy fields (Article I-12, Categories of competence).
- The European Council 'shall elect its President, by qualified majority, for a term of two and a half years, renewable once' (Article I-22, Clause 1). Furthermore, a Union Minister of Foreign Affairs is introduced. One not insignificant aim of these two steps is to give EU policies two faces to identify with.
- The Parliament co-decides with the Council of Ministers in those policy fields where qualified majority voting is applied.
- Member states can opt in or out of new policy initiatives more easily.
- A Charter of Fundamental rights is introduced (Part II of the constitution).

2.3.4 Latest developments

On 29 May 2005 and on 1 June 2005 the European Constitution was rejected in French and Dutch referenda. This actually brought the ratification of the constitution to a standstill. For the foreseeable future the EU's institutional status quo will thus be retained. This has a rather comfortable consequence for the issue of standardization: for the time being there is no need to consider any major changes to EU standardization policy and the ESS that might result from fundamental changes on the constitutional level of the EU. The thorough discussion of the European Constitution in the preceding chapters is not completely in vain, however. The Constitution is lying face down in the water, but it is not dead yet. Proponents of the constitution are eager to put it - somewhat modified, if necessary - back on the agenda as soon as there appears to be sufficient chance of a successful ratification.

3 Concluding remarks

The aim of this lecture was to provide an introduction to the basic attributes exhibited by the EU. It is to be hoped that readers will have gained an insight into the rather complex system of EU treaties, institutional structures, procedures and interrelations, but also to the historical circumstances which have often had a significant impact on the development of the EU. And with luck, readers will have been put into a position from which they can develop their own point of view with regards to the EU. Reader who wish to broaden their knowledge on specific EU-related topics may go to the References for a starting point.

It has been shown that there have been remarkable success stories but also grand failures in the process of European integration, and there is reason for criticism. The reader should bear in mind, however, that the EU is in many respects unique and many steps and measures towards European integration have been taken for the very first time in human history. Given this journey into uncharted territories, one can hardly expect every political initiative to proceed smoothly. In many cases, criticism of EU institutions and policies therefore comes easy - while the invocation of adequate remedies does not. For instance, alleviation of the democratic deficit addressed in Chapter 2.3.1 would involve the European Parliament being vested with additional powers, i.e. further steps towards a European federation. It is therefore difficult to complain about a democratic deficit in the EU while simultaneously objecting to the corresponding necessary steps towards federative structures. Regional integration is gathering pace all over the world - be it in Asia (Association of Southeast Asian Nations, ASEAN) or America (Mercado Común del Sur, Mercosur). Thus a close look at the European Union, its history, its institutional features, and its policies is indeed worthwhile. In many respects, the European Union provides a blueprint for successful political and economic integration which might be applied by other regional associations, organizations (or trade zones). In many cases EU officials displayed remarkable creativity in institutional design and provided astounding solutions for seemingly irresolvable problems. In another unit dealing with this topic, the reader will learn that Standardization Policy of the European Union is also an example of both creative and successful institutional design which exhibits a number of interesting design features and has significantly contributed to European integration.

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5 Glossary

Acquis Communautaire
Body of primary and secondary EU legislation (treaties, regulations and directives) which has irreversibly been built up so far, and the jurisdiction of the Court of Justice. The "Acquis" has to be adopted by each country that wishes to join the EU.

Codecision procedure
Decision-making procedure which empowers the European Parliament to "co-decide" jointly with the Council of the European Union on legal proposals submitted by the Commission of the European Union. The codecision procedure is the dominating decision mode in the EU and expands to 43 policy areas.

Committee of Permanent Representatives of the Member States, (Comité des représentants permanents, COREPER)
Highly influential body which assists the Council of the European Union. The Member States' Ambassadors ("Permanent Representatives") not only set agendas for council meetings but also negotiate preliminary positions on specific items.

Commission of the European Union
Body with far-reaching executive and legislative powers. The Commission is made up of 25 commissioners (one from each member state). Each Commissioner is assigned a specific policy area. The Commission - often called the "driving force" of European integration- is the only EU body entitled to propose legislation. The Commission is supported by administrative bodies, the Directorates-General.

Committee of the Regions (CoR)
The Committee of the Regions is an advisory board which represents regional and local authorities and has to be consulted by the Council, Parliament and the Commission as soon as the interests of regions are affected by EU policies.

Common position
Common positions are issued by Council of the European Union in the course of a codecision procedure or especially in the field of common foreign and security policy (CFSP) Depending on the issue in hand, qualified majority or unanimity is necessary to reach a common position.

Council of the European Union ("Council of Ministers", or "Council")
The Council of the European Union is made up of government ministers and represents the member states' governments. Together with the European Parliament, it decides on legislative and budgetary issues. The Council is especially influential in the fields of common foreign and security policy (CFSP), and in the coordination of economic policies. The composition of the council depends on its Agenda.

Council of Europe
The Council of Europe is an international organization of more than 40 countries. It is engaged in educational, cultural and human rights issues, is not an EU organ and has to be distinguished from the Council of the European Union and the European Council.

Court of Justice (Court of Justice of the European Communities)
The Court of Justice ensures that Community law is equally applied in each member state. It deals with infringements of EC law and is entitled to settle legal disputes between EU institutions, companies and individuals. Each member state provides one judge at present to the "Grand Chamber". The Court is supported by eight "advocates-general" which publicly and impartially present their opinions on the cases in hand.

Decisions
Made by the European Parliament, the Council, and the Commission a "decision shall be binding in its entirety upon those to whom it is addressed."

Directives
Made by the European Parliament, the Council, and the Commission, "a directive shall be binding, as to the result to be achieved, upon each Member State to which it is addressed, but shall leave to the national authorities the choice of form and methods."

Directorates-General (DG)
Administrative bodies which provide expertise and support in specific policy areas to EU organs (especially the Commission). A DG is headed by a 'Director-General'. The European standardization approach is for instance devised and managed under the auspices of the Enterprise Directorate-General.

eEurope
Initiative based on the Commission communication "eEurope - An Information Society for All", and launched in December 1999. Key objectives are among others to bring the digital age and the information age to Europe, and to support an entrepreneurial culture based on information technology.

EU Enlargement
This term refers to the accession of new countries to the EU. Each country which wishes to join the EU has to meet the so-called Copenhagen criteria (stable institutions, democracy, market economy, adoption of the acquis communautaire and so on). Enlargements usually provide both challenges and problems, but also chances an opportunities. In particular, the last enlargement in 2004 was of historic proportions and has brought fundamental changes to the EU.

European Atomic Energy Community (EURATOM)
EURATOM was called into life together with the European Economic Community on 25 March 1957 in Rome. It established a common approach to the civil use of nuclear power.

European Central Bank (ECB)
Based in Frankfurt the European Central Bank carries out the European Monetary Policy. Together with the national central banks, the ECB constitutes the European System of Central Banks. Equipped with the typical toolbox of a central bank the main goal of the ECB is price stability in the "Euro-Zone". It is held accountable to the European Parliament.

European Community (EC)
The European Community was established by the Treaty establishing the European Economic Community on 25 March 1957 in Rome. It was aimed at the "harmonious development of economic activities", a "continuous and balanced expansion" and "increased stability". To this end, a common (or single) market was to be created. The EC constitutes the most important pillar of the EU.

European Community Agencies
European Community Agencies are set up on the basis of secondary legislation, i.e. EU directives, for example, have their own legal personality and address specific technical, scientific or management tasks. Presently 16 different agencies are working in different fields such as Safety and Health at Work, Plant Variety and also Racism and Xenophobia.

European Convention
The European Convention, sometimes known as the Convention on the Future of Europe, was a body established by the European Council in December 2001 as a result of the Laeken Declaration. Its purpose was to produce a draft constitution for the European Union for the Council to finalize and adopt. The Convention finished its work in July 2003.

European Council
Regular meetings held by the leaders of the EU member states (assisted by the Ministers for Foreign Affairs) and the President of the Commission. The European Council makes far-reaching decisions on the path European integration should take. The European Council issues guidelines and sets priorities for EU institutions - usually in the form of declarations or resolutions.

European Court of Auditors
The Court of Auditors independently supervises the proper management of the EU budget. The Court has no legal authority of its own but informs those EU organs in charge, should any financial irregularity occur. The approval of the Commission's handling of the budget for instance crucially depends on the assessment of the Court of Auditors.

European Economic and Social Committee
The Economic and Social Committee is a an advisory body and represents various stakeholders and interest groups, such as employers, trade unions, farmers, consumers, i.e. social groups which actually constitute the "civil society" in Europe. The Committee issues opinions on various topics and provides a strong impetus for decision-making in the EU, as it has to be consulted whenever decisions on economic and social issues are being made.

European integration
Shift of power from member states to the EU level, the carrying out of EU policies and the subsequent convergence of living conditions.

European Parliament
The Parliament is the only EU organ which is directly elected by the EU citizens. Together with the Council it decides on legislative acts (submitted by the Commission), supervises other EU organs and holds budgetary competences. Presently, the EP is made up of 732 MEPs.

European Standardization System (ESS)
The European Standardization System (ESS) is constituted by the European standards bodies (CEN, CENELEC and ETSI) their structural interrelations, their structural relationships towards the European Union and towards other relevant actors.

European Union
The European Union is a family of European countries. It provides a framework for economic and political co-operation. Its 25 member states transferred substantial Elements of national sovereignty to the EU. Main goals of the EU are prosperity, freedom and the creation of a European identity.

Federalism
This term represents an idea or ideology tending towards greater integration, centralization and supranationalism within the European Union.

Federation
A federation is a state which consists of a central government and a number of self-governing regions. Competences are laid down in a Constitution and cannot be altered unilaterally by one side or another. Compared to a rather loose international organization like the UN, competences on the regional level are rather restricted. Strong europhiles prefer a federal EU.

Globalization
Term synonymous with the increased economic exchange and integration and the corresponding far-reaching social changes on the worldwide scale.

Institutional Triangle
The European Parliament, the Council of the European Union, and Commission of the EU are called the Institutional Triangle. The Institutional Triangle encompasses most legislative and executive powers within the EU.

Intergovernmental Conference (IGC)
Intergovernmental Conferences are held by the governments of the member states and usually deal with the amendment of EU Treaties. Consequently, far-reaching decisions are made in IGCs, e.g. on the modification of EU institutions, the restructuring of the treaties or the future general course of development that the EU is going to take. All major modifications to the Founding Treaties have been accompanied by IGCs.

Intergovernmentalism
This term refers to peer-to-peer decision-making in international organizations. No decision can be made against the will of one (or more) member states, i.e. unanimity is the decision rule of choice. The term is used both descriptively and normatively. Eurosceptics who prefer national independence to far-reaching European integration can usually be called intergovernmentalists.

Internal Market, Single Market, Common Market.
An internal market is created by the abolishment of all internal barriers of trade. This includes the creation of a customs union, the removal of all non-tariff barriers to trade and the freedom of movement of goods, services, capital and labour.

Laeken Declaration
The Laeken Declaration was concluded at the Laeken European Council on 14-15 December 2001 and requested the EU to be "more democratic, more transparent and more efficient". The Laeken Declaration paved the way for the European Convention, and the European Constitution.

Lisbon Agenda
The Lisbon Agenda was agreed upon on by the European Council in a special meeting in Lisbon on 23-24 March 2000. Its ambitious aim is to make the EU "the most competitive and dynamic knowledge-driven economy by 2010, capable of sustainable economic growth with more and better jobs and greater social cohesion".

Maastricht Treaty (Treaty of the European Union)
The Maastricht Treaty established the European Union, the three-pillar structure and laid the foundation for monetary union/the euro. The Maastricht Treaty was a milestone in European integration. Ratification, however, encountered difficulties.

Non-tariff barriers to trade, technical barriers to trade
All barriers to trade other than tariffs are called non-tariff barriers to trade. This term especially refers to national laws, regulations and indeed standards repositories which hamper the free movement of goods, capital and services.

Opinions
Made by the European Parliament, the Council, and the Commission 'recommendations and opinions shall have no binding force.' (Article 249 (ex Article 189) of the EC Treaty)

Primary legislation
Constitutional by nature, the primary legislation specifies basic policies, lays down institutional structures and procedures, and allocates the powers among the EU organs

Recommendations
Made by the European Parliament, the Council, and the Commission 'recommendations and opinions shall have no binding force.' (Article 249 (ex Article 189) of the EC Treaty)

Regulation
Made by the European Parliament, the Council, and the Commission 'a regulation shall have general application. It shall be binding in its entirety and directly applicable in all Member States.' (Article 249 (ex Article 189) of the EC Treaty)

Secondary legislation
Instruments, based on the Primary legislation. EU organs are empowered to make institutional arrangements among each other and issue legally binding acts such as Regulations, Directives, and Decisions. Jurisdiction of the Court of Justice

Service Directive
Abbreviation of the 'Proposal for a Directive of the European Parliament and of the Council on the Internal Market' (Interinstitutional File of 10 January 2005) which has drawn significant public attention. The proposed Service Directive expands the EU harmonization approach from goods to services but met resistance from national governments. It was handed back to the Commission for revision early in 2005.

Single European Act
The SEA provided the first major amendments to the EC Treaty. It implied a significant step towards European integration as national sovereignty was restricted in some policy areas. The SEA was aimed at the closer co-ordination of various policies, the completion of the internal market and the enhancement of international competitiveness - not least through technical harmonization.

Stability and Growth Pact
Adopted at the Amsterdam Council in 1997 the Stability and Growth Pact is aimed at the installation of fiscal discipline among the member states. The pact provides "convergence criteria" (e.g. annual budget deficit lower than 3% of GDP), as well as enforcement policies and penalty instruments. The criteria have, however, been applied inconsistently and were even 'watered down' recently.

Subsidiarity
The "subsidiarity principle" means that EU decisions must be taken as closely as possible to the citizen. In other words, the Union does not take action (except on matters for which it alone is responsible) unless EU action is more effective than action taken at national, regional or local level. (Eurojargon, http://europa.eu.int/abc/eurojargon/index_en.htm)

Technical harmonization
This term refers to the approximation of national technical laws and regulations and especially of standardization repositories in order to create a genuine internal market.

Three-pillar structure
Three pillars constitute the EU: the European Community pillar, the Common Foreign Security Policy pillar, and the Justice and Home Affairs pillar. Most of the supra-national elements of the European Union have been subsumed under the Community pillar whereas the intergovernmental elements, which provide a larger degree of national autonomy, are allocated to the CFSP and JHA pillars.

Treaty establishing the European Coal and Steel Community (ECSC Treaty)
The ECSC Treaty, which was signed on 18 April 1951, called into life the first of the three Communities (EEC, EURATOM, and ECSC), and put steel and coal under supranational control. The ECSC ceased to exist 50 years after its ratification on 23 July 2002.

Treaty of Amsterdam
The Treaty of Amsterdam was signed on 2 October 1997 and came into force on 1 May 1999. It addressed social and legal issues such as fraud prevention, immigration, fundamental rights and discrimination/equal rights, transparency of EU structures, and provisions on common foreign and security policy.

Treaty of Nice
The Treaty of Nice was signed on 26 February 2001. It addressed a number of urgent issues with regard to the upcoming enlargement, e.g. Commission size and composition, and the distribution of seats in the Parliament. It provided a stepping stone towards the EU Constitution.

6 Key questions

- What is the EU in essence?
- What is the "Institutional Triangle"?
- What is the difference between the European Union and the European Community?
- Which EU treaties are constitutional by nature?
- Will the European Constitution bring revolutionary or evolutionary change to the EU?
- What is meant by the term "European integration"?
- What distinguishes primary legislation from secondary legislation?
- What does the term 'Supranationalism' mean?
- What does the term 'Intergovernmentalism' mean?
- What will the future of the EU look like?

Wilfried Hesser · Axel Czaya

Abstract

This chapter deals with the standardization policy of the European Union and the basic characteristics of the European Standardization System (ESS). This is performed in three steps: firstly, an account is given of the build-up of European standardization structures and the development of EU standardization policies. Secondly, the basic characteristics of the ESS are dealt with. Thirdly, present issues and possible future developments in European standardization are considered. It is shown that both the ESS and the standards it produces play an important role in one of the most prominent EU projects, the creation of the 'Internal Market'. It is also shown that, although the present EU regime - the so-called 'New Approach' - is widely regarded as a success by EU organs, some problems still persist while others may show up in the future.

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1 Preface

1.1 Standardization and markets

Most scholars in the field of standardization will agree with the statement that the smooth functioning of markets (and advanced societies in general) is closely related to sound standardization structures. The relationships between market interaction (i.e. the exchange of goods - including the exchange of information which is relevant to the exchange of goods) and standardization became especially evident during the industrial revolution, when the expansion of markets to national and international levels was accompanied by the build-up of respective standardization structures and standards repositories. It also became evident that cause and effect relationships between standardization and market development are not always clear-cut: in some cases appropriate standards are not only a prerequisite for market interaction or the diffusion of new technologies into markets (and societies) but for the existence of specific markets as such. For example, without the underlying mobile communication standards, the fast-growing markets for mobile phone ringtones, logos and picture messages would simply be non-existent. In other cases not only the demand for specific standards, but even standards as such - so-called de facto standards - are generated within market systems. The dominance of Microsoft Operating Systems and software for Personal Computers is to a substantial degree a result of market interaction (Miller, 2005). Of course, one can also imagine market-generated standards which in turn shape other markets or even the market from which they emerged.

Relationships between standards and markets

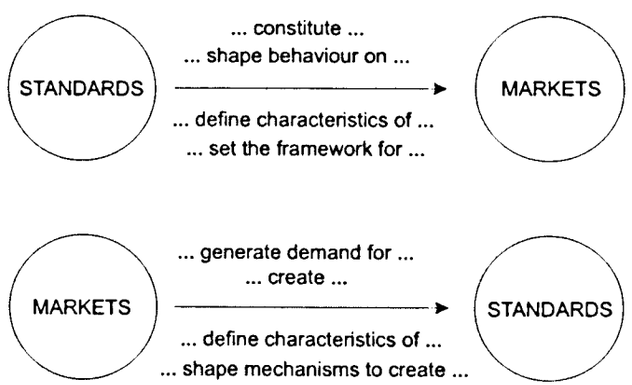


Figure: Relationships between standards and markets (© Hesser/Czaya)

1.2 The Internal Market and EU standardization policies

Given these interrelationships between standardization and markets, it comes as no surprise that the EU applies a full-scale standardization policy in support of one of its most prominent projects: the completion of the 'Internal Market'. It may come as a surprise, however, that it took the EU about 30 years to set up a fairly complete and smoothly functioning policy approach to standardization, as a brief look at the history of EU standardization policies will show.

In the Treaty of Rome of 1957 which envisaged the creation of an Internal Market (at that time called 'Common Market'), standardization issues were not addressed explicitly. The Common Market should have in the first place been set up by means of a customs union and an appropriate taxation policy. At the end of the nineteen-sixties, however, EU organs realized that different 'technical cultures', i.e. different technical rules, regulations and standards on the level of the member states imposed considerable barriers to the free movement of goods within the EU. Consequently, EU organs took the first steps to employ their own standardization policy.

This regulatory approach - in hindsight often called 'Old Approach' - turned out to be insufficient (for reasons to be seen in Section 2.2) and was abandoned in the mid-nineteen-eighties in favour of the so-called 'New Approach' which is in force until today. At the end of the nineteen-eighties, EU organs realized that certification and accreditation issues had been neglected and rushed to supplement the New Approach with a 'Global Approach' to conformity assessment which is also still in force.

1.3 Why EU standardization policy matters

Why is it worthwhile for a scholar in standardization to gain a sound understanding of the EU approach to standardization?

The reasons are among others:

- The New Approach illustrates how standards and standardization structures can be used (or, as some would argue, abused) as policy instruments to create an integrated regional market. One may also learn which mistakes can be made and which pitfalls exist along the way to a functioning regional standardization system.
- EU organs are keen to promote their approach to standardization in countries and regions outside the EU. In gaining sufficient knowledge, non-European scholars, in particular, are put in a position from which they can assess whether the New Approach (or some of its elements) is suitable for installation in their respective home countries or home regions.

- The Internal Market is presently the second biggest market in the world (in GDP).
- The New Approach has considerable practical impact on many if not all firms who wish to offer their products in the EU. These firms need to know how to comply with which European standards. A sufficient knowledge of the basic features of the ESS is also helpful in these practical matters.
- Even non-European firms can move from a passive position of a standards taker to an active position of a standards maker and influence the proceedings in EU standardization. But this once again requires a basic knowledge of the institutional features of the ESS.

Why EU standardization policy matters

- EU standardization policy has fundamental impact not only on the European level.
- Indispensable knowledge for companies that operate in the European Economic area.
- Even non-European firms can influence proceedings in EU standardization.
- Illustrates the use of standardization as a policy instrument and possible problems.
- European approach competes with other, market-oriented approaches to standardization e.g. on the international level.

Figure: Why EU standardisation policy matters (© Hesser/Czaya)

1.4 Some remarks on the structure of this module

The basic structure of this module corresponds to the chapter 'The regulatory framework of European standardization'. Chapter 2 covers some historical aspects of European standardization which are helpful (if not indispensable) for understanding the present state of the ESS. In Section 2.1 a brief look will be taken at the foundation of the first European standardization bodies in the early nineteen-sixties and the given historical context. Furthermore, the basic features of the first European approach to technical harmonization - in hindsight frequently called 'Old Approach' - are depicted in Section 2.2. Section 2.3 covers the present EU regime in technical harmonization - the so-called 'New Approach.' Emphasis is placed on the political dimension, as the New Approach - together with the corresponding approach to assessment and certification issues - will be discussed in detail in the respective chapter.

Chapter 3 deals with the present institutional state of the European Standardization System, which primarily comprises the European Committee for Standardization (CEN), the European Committee for Electrotechnical Standardization (CENELEC), and European Telecommunication Standards Institute (ETSI). In Section 3.1 the institutional features that CEN, CENELEC and ETSI have in common are portrayed, whereas Section 3.2 addresses differences between these bodies. In Section 3.3 the relationship between the ESS and international standardization structures is given due attention. In Chapter 4 some present issues and problems and possible future trends in European standardization are discussed. Concluding remarks are made in Chapter 4.

2 Historical aspects of European standardization

2.1 The early days of European standardization

The idea to resort to standardization for the reconstruction of Europe emerged shortly after World War 2. Under the auspices of the Organization for European Economic Co-operation (OEEC), a body founded in 1948 to coordinate the Marshall Plan, representatives from West European countries met on a regular basis to discuss the scope for cooperation in the field of standardization (CEN, 1995, 7). Simultaneously, (West) European integration gathered pace in the nineteen-fifties. This process, however, evolved not without conflicts. Some West European countries such as the United Kingdom, Austria, Switzerland, Norway, Sweden, Denmark and Iceland objected to the French-led approach to integration within the framework of the European Communities. These countries would have preferred a much looser economic cooperation and disagreed with the initiative to expand European integration to the political realm. On 3 May 1960, these countries founded the European Free Trade Association (EFTA) as a counterdraft to the European Economic Community. In 1958, shortly after the Treaty establishing the European Economic Community (EECT) was signed, standards bodies of the member states gave in to the plausible idea to call into existence corresponding European standardization structures - and excluding non-EEC states from participating.

This prompted Standards Bodies from EFTA-states - who still held regular sessions with their EEC counterparts under the aegis of the OEEC - to intervene. When CEN eventually held its constitutional meeting on 22 and 23 March 1961, Standards Bodies both from the EEC and EFTA states were allowed membership. The predecessors of CENELEC, the European Committee for the Coordination of Electrotechnical Standards in the European Economic Community (CENELCOM) and the European Committee for the Coordination of Electrical Standards (CENEL) also emerged from the events described above but were established

slightly earlier than CEN. CENEL was called into existence in 1960 and was made up of the members of CENELCOM and the national electrotechnical committees of the EFTA member states. It should be noted that, although phrases like 'EU standardization policy' are used frequently in this module, EFTA states participate in European standardization on an equal footing.

2.1.1 European standardization activities in the nineteen-sixties

During the nineteen-sixties European standards bodies (CEN, CENELCOM and CENEC) displayed almost no activities (CEN 1995, 9). There was actually no standardization work being carried out and consequently, no working documents or standards were published. This was due not only to some lack of initiative but also to the result of the self-defined scope of work: European standards professionals still acknowledged the duality of national and international standardization and especially the primacy of international standardization. European standards bodies were not established from the outset to draw up genuine European standards, but rather to support international standardization and to develop common European positions with regards to international standards. As long as standardization on the international level was working effectively, standardization efforts on a European level were not considered necessary. It should be noted that the foundation of CEN, CENELCOM and CENEC was based on private initiative and had neither been enforced nor encouraged nor supported by political actors. During the nineteen-sixties no formal links existed between CEN, CENELCOM, CENEC and EU organs. Neither CEN nor CENELCOM nor CENEC were formally 'acknowledged' or 'recognized' by EU organs as 'European standards bodies' nor did they act on behalf of EU policies or interests.

2.1.2 Some early conclusions from the early days of European standardization

Some conclusions can readily be drawn from this chapter:

- Although based on private initiative, the foundation of the first European Standards Bodies was motivated not only by technical and economical but also by political considerations.
- The differences on the political level were nevertheless reproduced to some degree on the level of standardization.
- European standards professionals eventually accomplished something on the level of standardization that European politicians were not able to achieve on the political level: to bridge the gap between EFTA and EEC states and to build up common standardization structures open to EFTA und EEC members. This illustrates the integrative momentum inherent in standardization.

- This point has not been explicitly mentioned but shall nevertheless be stated: during the Second World War, each side applied advanced methods of standardization. Although adequate standardization is a necessity to prevail in modern warfare, cooperation in standardization issues can also help 'to win the peace' in the aftermath of a war.

2.2 The Old Approach to harmonization

At the end of the nineteen-sixties significant developments on the political level took place. As already mentioned, EU organs realized that the removal of customs duties and quantitative restrictions are insufficient to create a Common Market. Different national laws, rules and regulations and standard repositories, i.e. different 'technical cultures', imposed strong restrictions on the free movement of goods in the EC (Nicolas & Repussard 1994, 71). EU officials realized that a European approach to standardization and harmonization of national laws and regulations was indispensable for the successful completion of the Common Market. Such a European approach to standardization had to be based on the existing system of European treaties and body of jurisdiction in order to be legally valid. Although standardization issues had not been directly addressed in the founding treaties, Articles 28 (ex-30) 30 (ex-36) and 94 (ex-100) EECT provided a basis for appropriate secondary legislation and action to be taken.
Article 28 (ex-30) prohibits 'all measures having equivalent effect' to quantitative restrictions, Article 30 (ex-36) deals with exceptions to this article, and 94 (ex-100) entitles the Council to adopt Directives to approximate/harmonize such national rules and regulations which have a detrimental effect on the establishment of the Common Market. On 28 May 1969 the 'Programme to remove the technical barriers in the trade of commercial products arising from the different laws and regulations of the Member States' was introduced. This marked the beginning of the first European approach to remove the technical barriers to trade, which with hindsight is often referred to as the 'Old Approach' (Pelkmans, 1987, 253).

The main characteristics of the first approach to technical harmonization were as follows:

- A considerable number of Directives in various technical fields should be drawn up.
- Directives were legally binding on the national level, and conflicting laws, rules, regulations had to be withdrawn.
- Community organs were ready to do the work largely on their own including the work on technical details.

• The Council had to decide unanimously on the final version of a Directive.

The ambitious harmonization approach soon encountered various serious problems and had to be abandoned for the following reasons (see Pelkmans, 1987, 253):

- Decision making was far too cumbersome and took far too long. Many Directives, which took several years to be adopted, were often out of date by the time they came into force.
- Standardization on the national level was still being carried out even in those fields in which the EC was working on Directives. These national rules and standards were usually produced much faster than their European counterparts.
- Member states had problems implementing those Directives adopted by the Council.
- EU organs were not especially keen to hand over work items to other actors or organizations, in particular to the standards community. This resulted in an inefficient allocation of tasks and excessive tendency towards unification.
- EC organs were working on technical issues for which they eventually turned out to be unqualified.
- Issues of certification and accreditation were ignored.

Eventually, the ambitious overall aims were by no means reached. Considerable resources were spent on the creation of only a few Council Directives. From the introduction of the 'Programme to remove the technical barriers' in 1969 to the introduction of the 'Information Directive' in 1983, only about ten Directives were published per year on average. These Directives tended to focus on specific attributes of specific products and therefore failed to produce a fundamental reduction in those technical barriers which hampered the free movement of goods in the Community.

At the end of the nineteen- seventies, the complete failure of the Old Approach to harmonization and the need for a fundamental regime change became obvious.

Elements of the Old Approach

- Large numbers of European Directives with normative content for individual products.
- Directives were legally binding on the national level.
- Conflicting standards had to be withdrawn.
- Work on technical details was largely done by Community organs.
- Council decided unanimously on the final version of a Directive.

Figure: Elements of the Old Approach (© Hesser/Czaya)

2.3 The New Approach to standardization and harmonization

2.3.1 The political context at the beginning of the nineteen-eighties

At the end of the nineteen-seventies not only the European standardization policy but the whole project of European integration was in rather bad shape: the almost exclusive application of the unanimity principle severely hampered decision making in the EC. The oil shock in 1973 and subsequent economic crisis led to a revival of protectionist policies on the national level. As a result, political decision making increasingly shifted away from the European level to the national level in the late seventies. This stage of European integration is usually subsumed under the term 'Eurosclerosis'. In the 'Solemn Declaration on European Union' of June 1983 the heads of the EC member states expressed their commitment to reviving the European idea and to taking further steps towards European integration. One aim among others was the completion of the Internal Market which implicitly called for a realignment of the whole European regulatory approach. The challenge for EC organs was now to devise such a new regulatory approach - including a new standardization policy - which could do away with the shortcomings of the Old Approach and effectively support the plans for greater European integration.

2.3.2 Some remarkable waypoints towards the New Approach

Some events significant for the introduction of the New Approach (and European standardization in general) have not been mentioned so far. These events are the introduction of Directive 73/23/EEC of 19 February 1973 ('Low Voltage Directive'), a ruling of the Court of Justice in the so-called 'Cassis de Dijon case', and the introduction of Directive 83/189/EEC ('Information Directive' or 'Transparency Directive').

2.3.3 The Low Voltage Directive

The Low Voltage Directive covered the free movement of goods operating between 50 and 1000 Volts and already incorporated elements which were later applied in the New Approach. In the case of Low Voltage Equipment it became obvious to EC organs that it was virtually impossible to draw up a Directive for each relevant good. This would have resulted in the creation of thousands of Directives. In order to avoid this, a number of new notions and concepts were introduced (Vardakas, 2003, 2):

- 'Harmonized standards' are agreed upon by National Standards Bodies in the EC and implemented on the national level. These harmonized standards incorporate the requirements laid down in the Directive. Compliance with

these standards allows a product to be marketed and moved freely in the EC (73/23/EEC, Article 5).
- Where harmonization does not yet exist, the reliance on international standards or equivalent domestic standards is sufficient for the free movement of products (73/23/EEC, Articles 6&7).
- The Low Voltage Directive created the political momentum to acknowledge CENELEC as the institutional locus where harmonized standards in the electrotechnical field should be drawn up.
- As intended, the Low Voltage Directive avoids singling out specific products but covers a whole range of products.

2.3.4 The Cassis de Dijon case

In the Cassis de Dijon case the European Court of Justice handed down a ruling on 20 February 1979, which had significant repercussions for the Common Market (Vardakas 2003, 3). Based on its rule-of-reason and Art.30 EC, the European Court of Justice introduced the concept of mutual recognition and stated that '*any product lawfully produced and marketed in one Member State must, in principle, be admitted to the market of any other Member State.*' Obstacles to movement are only justified if '*the effectiveness of fiscal supervision, the protection of public health, the fairness of commercial transactions and the defence of the consumer*' should be affected. Since the Cassis de Dijon ruling regulatory intervention (and the use of standardization as a regulatory instrument) by EC organs is only justified should issues of safety, health, environment and consumer protection ('SHEC') be at stake. The regulations that might be drawn up in those cases aim at the approximation of different national laws, rules and regulations. These 'Approximations', however, should only be set up if absolutely necessary and should only go as far as necessary. See Pelkmans (2003) on the concept of mutual recognition and the regulatory implications of the Cassis de Dijon ruling.

2.3.5 The Information Directive

As seen in Section 2.4, standardization on the national level was carried out even in those fields in which EC Directives were in preparation. From the Commission's point of view these uncontrolled standardization activities impeded the creation of a harmonized and consistent European standards repository and had to be brought under control. To this end, Council Directive 83/189/EEC of 28 March 1983, laying down a procedure for the provision of information in the field of technical standards, and regulations was passed.
Under Directive 83/189/EEC a member state is obliged to inform the Commission and each other member state about all draft technical regulations and draft standards, thus providing greater transparency and a better flow of information in standardization issues. Furthermore, a member state is obliged to suspend the

adoption of draft technical regulations or standards in order to allow examination, comments and - if considered necessary - appropriate action by the Commission and member states. Furthermore, Directive 83/189/EEC lists all 'acknowledged' or 'recognized' national and European standards bodies and sets a legal framework for the cooperation between these bodies and EC organs. Directive 83/189/EEC was amended by Directive 98/34/EC in 1998 in order to include information society services.

The Information Directive had an impact on national sovereignty and the independence of national standards bodies, as additional restrictions to draw up and put into force technical regulations and standards were introduced. The Information Directive was met with open hostility, particularly from some quarters of the standards community. CEN, for example, was assigned additional tasks by the Information Directive it had to cope with (CEN, 1995, 20). For the time being, the reader may bear in mind that both the Cassis de Dijon ruling as well as the Information Directive significantly interfered with the sovereignty of the EC member states.

2.3.6 Basic elements of the New Approach

The Council Resolution of 7 May 1985 on a new approach to technical harmonization and standards (Official Journal C 136, 04/06/1985) introduced the new standardization policy and outlined some of its basic characteristics. The blueprint for the New Approach was laid down in the White Paper on the Completion of the Internal Market (COM (85) 310 final).

In the White Paper the Commission deliberates on the issue of standardization (COM (85) 310 final, 17-19):
- The removal of diverging national product regulations and standards is regarded as a prerequisite for the creation/completion of the Common Market.
- Exclusive reliance on an unmodified Article 100 EECT and its unanimity principle will not suffice to meet the ambitious timetable set by the EC - especially with regards to the plan to create a genuine Common Market by 1992.
- The creation of a Common Market as such will not suffice. Additionally, the Common Market needs to be sufficiently flexible, competitive, and needs to exhibit adequate potential for growth.
- Although the principle of mutual recognition of national rules, regulations and product laws might create a Common Market, it may well prove inadequate to provide sufficient competitiveness. At the same time full-scale harmonization, as had been attempted with the Old Approach - proved to be much too time-consuming and over-regulatory. Consequently, an in-between approach is needed which combines 'the best of both worlds'.

The basic elements of the New Approach are as follows:

- European legislative and political domains are clearly separated from the domain of European standardization.
- EC legislation, i.e. regulatory intervention by EC organs, is limited to the definition of essential requirements when public interest is affected. For EC organs and basically in line with the Cassis de Dijon ruling, public interest particularly exists in the fields of quality, safety, consumer protection and environmental protection ('Essential Requirements' has become a technical term commonly used in the context of European standardization).
- Whenever EC organs identify the need for action in the respective fields, Essential Requirements may be drawn up. European Directives are usually the legislative instruments by which Essential Requirements are brought to bear. European Directives are legally binding and have to be implemented in national law.
- A New Approach Directive is drawn up by a Standing Committee of a Directive. Composed of experts in the given field, the Committee also supports the implementation of a Directive.
- The drafting of technical specifications, i.e. standards which are based on Essential Requirements, is handed over to European standards bodies. These Bodies draw up so-called 'Harmonization Documents' or 'Harmonized Standards' which have to be implemented on the national level. Simultaneously, contradicting national standards have to be withdrawn.
- The 'presumption of conformity trick': when drawing up the New Approach, decision makers were caught in a quandary: Essential Requirements were to be legally binding - while the use of those standards which incorporate Essential Requirements were still to remain voluntary. This conflict was resolved by the presumption of conformity concept: under the New Approach the application of European standards is still voluntary. The application of European standards warrants a 'presumption of conformity': whenever European standards are applied, conformity with the Essential Requirements can be assumed and the respective goods are allowed to move freely in the EC. The application of European standards is a convenient way to comply with the underlying Essential Requirements which gives produces and their engineers legal certainty about intra-EU market access. Producers are nevertheless allowed to rely on non-European standards. In this case, however, conformity with the Essential Requirements has to be proven, e.g. by adequate testing.
- Conformity to Essential Requirements is indicated by applying the CE Mark to a given product.
- The publication of a new standard is indicated in the Official Journal of the European Commission - together with those Directives for which the presumption of conformity applies.

Basic elements of the New Approach

- Political domain and standardization domain are clearly separated
- Regulatory intervention by EC organs is limited to the definition of essential requirements when public interest is affected
- Public interest is given in the fileds of quality, safety, consumer protection and environmental protection
- Essential Requirements are laid down in European Directives.
- The preparation of technical specifications, i.e. standards wich are based on Essential Requirements, is handed over to the European standards bodies. European standards bodies draw up "Harmonization Documents" or "Harmonized Standards" which have to be implemented on the national level. Simultaneously, contradicting national standards have to be withdrawn.
- Closely cooperates with CEN and ETSI in various advanced programmes.
- Whenever European standards are applied and indicated by applying the CE Mark, conformity with the Essential Requirements can be assumed, and the respective goods are allowed to move freely in the EC ("presumption of conformity").

Figure: Basic elements of the New Approach (Source: Vardakas 2003)

Presently, more than 20 NA Directives exist in fields such as safety of toys, pressure equipment, electromagnetic compatibility, construction products and explosives for civil uses. There are also Directives which are based on NA principles but do not provide for CE Marking. For details see the Commission website on the Single Market. At first glance, the logic of the New Approach is difficult to grasp. How can the use of European standards be voluntary while the underlying EU Directives are obligatory? The answer is given below.
The application of European standards (Harmonized Standards) is sufficient to comply with the Essential Requirements, but not necessary. Adherence to EU Directives is obligatory, but there are instruments other than European standards to meet this requirement. The application of European standards is nevertheless recommended by EU authorities as the most convenient way of complying with Essential Requirements. Beyond a mere recommendation by EU authorities, the incentive for producers and importers to rely on European standards is amplified by product liability considerations: relying on European standards implies being on the 'safe side' when it comes to product liability issues (European Commission, 2000, 26). Furthermore, the 'gravitational forces' exerted by the European standards repository are intensified by the role

European standards (which are necessarily based on New Approach Directives) play in public procurement.

Logic of the New Approach

The application of European standards is **a sufficient condition** to comply with the Essential Requirements, **not a necessary condition**.

Figure: Logic of the New Approach (© Hesser/Czaya)

2.3.7 The Global Approach to certification and testing

A European approach to standardization inevitably had to be supplemented by a European approach to certification and accreditation, as the success of a standardization regime crucially depends on a corresponding regime of conformity assessment. In Council Resolution of 21.12.1989 the 'Global Approach' to certification and testing was introduced, while in Council Decision 93/465/EEC of 22 July 1993, a number of technical and procedural issues concerning the Global Approach were specified. The issue of European certification and accreditation is actually too complex to be addressed any further at this point. See the module on conformity assessment which deals with this issue in detail.

2.3.8 Old Approach and New Approach compared

Compared to the Old Approach, the introduction of the New Approach brought about substantial improvements in virtually every respect:

- The New Approach works, while the Old Approach has failed in many fields. The Old Approach has not been completely replaced by the New Approach, however. In some safety-related areas Old Approach policies are still in place.
- Regulatory intervention by EC organs was significantly reduced.
- EC organs were relieved of tedious work on technical details for which they were ultimately not suited.
- EC organs moved closer towards the relevant actors and appreciated their needs, especially in the marketplace.
- Given a better allocation of tasks and a clear assignment of roles for all relevant actors, the European standardization bodies were prepared to put out those large numbers of European standards which were needed in support of the ambitious plans to set up a European Union and to create an Internal Market by 1992. Indeed, the number of European standards published each year significantly increased towards the end of the nineteen-eighties.
- The introduction of the New Approach gave CEN a substantial push. Within a few years, CEN was promoted from a sleepy association which was more or less founded to do nothing (CEN, 1995, 25) to a global player in standardization.

On the technical level, the New Approach introduced the following improvements:

- The Directives do not address individual products, but families of products.
- The Directives cover horizontal risks for those families of products. This horizontal coverage of risks actually defines a 'family of products'.
- The Directives tend to be performance-based rather than prescriptive. They lay down in a general fashion what levels of protection or safety have to be maintained. This avoids a detailed description of how to achieve those levels. Hence innovation is not inhibited because it is possible to pursue different technological paths in order to comply with a given EC Directive. European standards are nevertheless put into a privileged position as their use is recommended by EU authorities.
- The rather general nature of the Directive's contents avoids regular revision with regard to technical progress.

2.3.9 Problems with the New Approach

One basic problem under the New Approach is the drawing up of Essential Requirements. The challenges EU legislators face are (Vardakas, 2003, 6):

- Essential Requirements must be operational: it must be possible to translate them into Harmonization Documents and European standards.
- It should, of course, be possible to comply with Essential Requirements and the related European standards.
- Essential Requirements must be formulated in a concise and consistent fashion.
- Essential Requirements must be directly and uniformly enforceable.
- Of course, a profound knowledge of the matter in question is still necessary.
- Essential Requirements should be sufficiently abstract. A relative distance to traditional approaches to the drafting of technical specifications can be helpful in this respect.

Meeting these criteria is no easy task and not all New Approach Directives succeed in doing so (Vardakas 2003, 5). Additional problems and improvements that came along with the New Approach are discussed in Chapter 4.

Requirements that New Approach Directives should meet

- It must be possible to translate them into Harmonization Documents and European standards.
- It must be possible to comply with Essential Requirements and the related European standards.
- Essential Requirements must be formulated in a concise and consistens fashion.
- Essential Requirements must be directly and uniformly enforceable.
- A profound knowledge of the matter in question is necessary
- Essential Requirements should be sufficiently abstract.

Figure: Requirements that New Approach Directives should meet (Source: Vardakas (2003, 6).

3 The institutional status quo of the European Standardisation System

Now that the political dimension of the EU approach to standardization has been outlined to some degree, a closer look will be taken at the ESS and its institutional attributes. This is done in a fashion that deviates from the common sequential approach. In Section 3.1 statements are made that hold for all three ESOs, and the features that CEN, CENELEC and ETSI have in common are summarized. Section 3.2 consequently deals with those attributes distinctive to each organization. This approach avoids some tedious repetitions.

In Section 3.3 the relationship between ESOs and International standards bodies is given special attention. A detailed account of each ESO and its institutional features is beyond the scope of this module. For further information visit the respective web sites of CEN, CENELEC and ETSI, and see Falke and Schepel (2000) for an almost encyclopaedic account of the ESS and its attributes from a legal perspective. In this module, however, it is shown that many institutional differences that CEN, CENELEC and ETSI exhibit can be fairly well explained by differences in the respective working fields, environments, and by historical aspects.

3.1 Attributes that CEN, CENELEC and ETSI have in common

CEN, CENELEC and ETSI share a set of institutional core features that are typical for 'classical' standards bodies. CEN, CENELEC and ETSI are associations - CEN & CENELEC under Belgian law and ETSI under French law. CEN, CENELEC and ETSI are formally independent organizations that are neither integrated in EU structures nor subordinated to EU organs.

CEN in a nutshell

- The CEN *System*: 28 Members (National standard bodies of EU and EFTA member states), 8 East European Affiliates, 2 EU Counsellors and the CEN Management Centre, Brussels.
- Private, non-profit, established in 1975, prepares voluntary standards in all fields other than ICT and electrotechnology, officially recognized by the EU.
- CEN produces European standards, Technical Specifications, (CEN TS), Technical Reports (CEN TR), and CEN Workshop Agreements.
- 11,087 European standards and approved documents, 282 active technical committees and 5,196 Documents under preparation at the end of 2004.
- Sectorally structured in *Business Domains.*
- ISO is the partner of choice on the international level.
- Financing: 55% Membership fees and 39% European Comission.
- Closely cooperates with CENELEC and ETSI in various advanced programmes.

Figure: CEN in a nutshell (Source: CEN Annual Report 2004, and http://www.cenorm.org as seen on 10 December 2005.)

As is usual for associations, institutional fundamentals like mission/purpose, aims, scopes of activities, structures and procedures or member rights and obligations are laid down in statutes and related documents, e.g. rules of procedure or internal regulations. These documents - together with CEN, CENELEC and ETSI web resources - provide the main sources of information for this chapter. The institutional convergence between CEN and CENELEC is especially advanced, as both organizations share the same Internal Regulations. Furthermore, CEN and CENELEC held their first common Annual Meeting in June 2005. ETSI in turn differs significantly from CEN and CENELEC in some respects, as will be shown in Section 3.2.

CENELEC in a nutshell

- Active in electrotechnical standardization, 28 Members (National Electrotechnical Committees) of EU and EFTA members states, 8 East European Affiliates and 33 Cooperating Partners (European industry associations).
- Private, non-profit, created in 1973, prepares voluntary standards, officially recognized by the EU.
- 4,951 active Standards at the end of 2004.
- Closely cooperates with the IEC. In 2004 68% of all CENELEC standards were identical to and 8% based on IEC standards
- Financed in the first place by member contributions and contractual income.
- Closely cooperates with CEN and ETSI in various advanced programmes.

Figure: CENELEC in a nutshell Source: CENELEC Annual Report 2004, CENELEC facts & Figures (www.cenelec.org, as seen on 10 December 2005)

ETSI in a nutshell

- ICT standards organization, 650 + Members (80% private sector)
- Private, non-profit, created in 1988, officially recognized by the EU.
- Financed upt to 70% by membership fees (20% public funding & member voluntary contributions, 10% sales).
- Open to all players worlwide > 20% + members from overseas.
- A track record of standards having enabled industrial hits worldwide.
- Best in class interoperability services (conformance, IOP testing, ...).
- Forum hosting activity.
- Intellectual Proberty Right policy based omn FRAND principles ("fair, reasonable and non-discriminatory").
- Standards free of charge on the Web.

Figure: ETSI in a nutshell (Source: Friis, J. and Dor, M., 2005)

3.1.1 Adherence to a set of 'basic principles of standardization'

A look at the respective mission statements or statutes shows that CEN, CENELEC and ETSI - although the wording is adapted to the respective working fields and may differ accordingly - adhere to a set of 'basic principles of standardization':

- Openness: Basically, all interested parties may take part in standards preparation. In the case of CEN and CENELEC, however, these parties are in the first place represented by delegations of national Ssandards bodies (of EU- and EFTA-member states).
- Transparency: Standard projects and draft standards are open to public scrutiny and comment.
- Consensus: In Technical Committes the consensus principle is the decision-making mechanism of choice. Divergence from the consensus principle, e.g. some form of majority voting, may be induced by the chairman of a Technical Committee, should consensus be beyond reach (CEN/CENELEC Internal Regulations, 3.2.3.3). For the approval of European standards, weighted voting procedures are applied.
- Voluntary use of standards: Although national standards bodies are obliged to implement European standards on the national level; no-one is forced to use a specific European standard.
- Technical coherence: CEN, CENELEC and ETSI adhere to the principle of a consistent and well-managed European standards repository.
- Primacy of international standardization: The primacy of international standardization is basically acknowledged by CEN, CENELEC and ETSI who emphasize their close ties with ISO, IEC and ITU, their respective counterparts on the international level. Although regional standards bodies by nature, CEN, CENELEC and ETSI aspire to be 'global players' in standardization (and certainly are).

These principles are of course acknowledged by the EU and are also in line with the principles for the development of international standards of the WTO Committee on Technical Barriers to Trade.

3.1.2 General Assembly

The highest decision-making body in all three cases is the General Assembly in which Members exercise their voting rights and decide on fundamental matters, such as the budget, new memberships and appointments, but also on political and strategic issues. See ETSI Directives/ETSI Statutes (2004, 11), CENELEC Articles of Association (2004, 4), and CEN Statutes (2004, 5) for details.
Furthermore, with regard to each ESB, it is useful to distinguish between an administrative organization, a technical organization, and a central secretariat.

3.1.3 Administrative organization

The main component of the Administrative Organization is the Administrative Board (or simply 'Board', as in the case of ETSI). The Administrative Board executes the decisions made in the General Assembly, manages and monitors the organization as a whole, oversees the production of Normative Documents, prepares decision making in the General Assembly, and the like. See ETSI Directives/ETSI Statutes (2004, 14), ETSI Directives/Board Working Procedures (2004, 61), CENELEC Articles of Association (2004, 5), CEN Statutes (2004, 8), CEN/CENELEC Internal Regulations Part 1A: CEN/ Part1B: CENELEC for details.The Administrative Board may be supported by additional organizational entities, especially committees. In the case of CEN, for example, the Consultative Committee for External Policy advises the Administrative Board on behaviours and strategies with regard to the European political environment or international standardization.

3.1.4 Technical organization

In the case of CEN and CENELEC, the technical organization comprises the Technical Board, which supervises and coordinates the core activities of standards preparation, and a structure of Technical Committees, Working Groups, Task Forces, and Project Teams of varying degrees of complexity. In the case of ETSI, neither a Technical Board nor a comparable organizational entity exists. The associated tasks and functions are performed by the Board and the ETSI Secretariat. In each ESO the essential standardization work is done in Technical Committees and conforms to a set of basic principles described below. Committees play a key role in each ESO. Committees can be handled flexibly, called into life ad hoc if necessary and immediately dissolved if they should not be needed anymore. Committees not only do the work on standards and other Normative Documents, but may also be set up to support other organizational entities such as the Administrative Board or the General Assembly, e.g. in administrative, financial or strategic issues. Working Groups may be called into existence by a Technical Committee to elaborate on especially intricate problems or controversial issues. Task Forces may be set up to give high-priority issues an intensive treatment. ETSI, for instance, introduced 'Specialist Task Forces' (STF) to speed up the production process and to respond to urgent market needs. STFs are made up of experts who may, if necessary, work full-time on high-priority items. Each Technical Committee is usually supported by a secretariat. For further information on the respective technical organizations see ETSI Directives/ETSI Statutes (2004, 14), ETSI Rules of Procedure (2004, 22), ETSI Technical Working Procedures (2004, 77), CENELEC Articles of Association (2004, 4), CEN Statutes (2004, 5), and CEN/CENELEC Internal Regulations, especially Common Rules for Standards Work and Rules for the Structure and Drafting of European Standards ('PNE Rules').

3.1.5 CENELEC Central Secretariat, CEN Management Centre, and ETSI Secretariat

Despite different naming and partly differing organizational approaches, the CENELEC Central Secretariat, CEN Management Centre, and ETSI Secretariat perform functionally equivalent tasks, i.e. to run the daily operations, to coordinate and to provide services to all organizational entities, and to interact with the environment. The central secretariats play a vital role for a seamless workflow and have frequently been re-organized in order to perform their tasks more efficiently. For details see ETSI Directives/ETSI Statutes (2004, 24), CENELEC Articles of Association (2004, 5), and CEN Statutes (2004, 9) and the respective Annual Reports which feature the most recent changes to structures and processes.

3.1.6 Prominent positions within European standards organizations

CEN and CENELEC are each headed by a President who also presides over the General Assembly. See CEN Statutes (2004, 7) and CENELEC Articles of Association (2004, 5) for details on the Presidents' tasks. Of similar prominence in both organizations are the highest-ranking 'executive officers', called Secretary General in the case of CEN and Director General in the case of CENELEC (see CEN Statutes (2004, 9) and CENELEC Articles of Association (2004, 5)). In both cases, the Secretary General or the Director General is 'in charge of the association's current and daily business and has all the powers related thereto' (CEN Statutes 2004, 9) and heads the respective central secretariat (CENELEC Central Secretariat, CEN Management Centre) within the organization. In the case of ETSI no such position as a President exists. The corresponding tasks are instead allocated to the chairman of the General Assembly and the chairman of the Board. The ETSI Director-General performs tasks analogous to those of his CEN and CENELEC counterparts. See ETSI Statutes (2004, 14) for details.

3.1.7 Similar membership categories

CEN, CENELEC and ETSI offer a variety of membership categories in order to allow the various actors to acquire membership with different rights and obligations. Full Members enjoy all rights and obligations as specified in the respective statutes. Eligible for full membership in CEN and CENELEC are the national standards bodies of EU and EFTA member states and of countries likely to become members of the EU or EFTA (CEN Statutes, Art. 6.1 & 6.2). Associates (CEN) and Associate Members (ETSI) are granted only restricted rights with regard to high-level decision making in the General Assembly. CEN Associates are 'broad-based European organizations, representing particular sectors of industry as well as consumers, environmentalists, workers, and small and

medium-sized enterprises'. ETSI Associate Members are in the first place manufacturers, service providers, and research and government bodies who actively take part in ETSI's work program but do not meet all the criteria to become Full Members. Counsellors represent the European Commission and EFTA within CEN, CENELEC and ETSI. Counsellors are allowed to take part in most activities in all organizational entities (e.g. the General Assembly and Technical Bodies), contribute especially when policy issues are on the agenda, but enjoy no voting rights. Counsellors obviously interface with ESOs and the political realm. Observers are basically entitled to be Full Members or Associate Members of ETSI but do not wish or need to actively participate in ETSI's work and may become Observers. Observers are frequently updated on ETSI's activities and may, for example, take part in the General Assembly without voting rights.

3.1.8 The role of national standards bodies in CEN and CENELEC

National standards bodies of EU and EFTA member states perform a number of important tasks in CEN and CENELEC. NSBs, for example, implement European standards, sell and distribute CEN and CENELEC publications on the national level, dispatch delegations to Technical Committees, Subcommittees and Working Groups of CEN and CENELEC, and participate in decision making on the technical, managerial and political level. In order to perform their tasks and to accompany standards preparation on the European level, NSBs usually set up so-called mirror committees. NSBs also provide secretaries to CEN/CENELEC Technical Committees and Subcommittees. The 'country model' applied by by CEN and CENELEC, but also by ISO and IEC, provides for individual stakeholders only indirect access to standards activities on the European level and has been subject to debate. For example, some companies would prefer to represent their positions in a more direct manner, while NSBs, being indeed in a somewhat privileged position, point at the advantages that the country model has to offer. See de Vries (1999, Section 4.4.5) for a discussion of the country model.

3.1.9 Cooperation with external actors

Cooperation with external actors can take a remarkable variety of forms. Common to all ESOs is that virtually no external actor who might be relevant with regard to standardization, and no form of cooperation is a priori excluded. A brief look at CEN shall suffice at this point. CEN, CENELEC and ETSI coope-rate with other organizations who prepare standards or technical specifications on the European level. CEN, for instance, grants the European Committee for Iron and Steel Standardization (ECISS, www.eurofer.org) and the European Association of Aerospace Manufacturers (AECMA,www.aecma-stan.org) the status of 'Associated Standards Bodies'.

CEN also welcomes input of various kinds from organizations like the European Cooperation for Space Standardization (ECSS), European Directorate for the Quality of Medicines/EPC - European Pharmacopoeia Commission (EDQM), European Organization for Technical Approvals (EOTA), European research organization (EUREKA), and the Joint Research Centre of the European Commission. Basically, ESO takes in technical specifications from all conceivable sources and may promote them to become European standards. Furthermore, European trade or professional organizations may have a 'liaison status' with a CEN technical committee (See www.cenorm.be) for a remarkably long list of associations, unions, research bodies, and the like, who fall into this category. In promotion of the ESS, ESOs have recently started to send out 'Standardization Liaison Officers' to important trade partners like China. Cooperation with various countries and regions can also take the form of technical assistance, meetings and conferences (CEN, 2004, 15).

The concept of Partner Standardization Bodies (PSB) is especially interesting (CEN, 2004, 15): PSBs are not eligible to become Full Members of CEN but are granted the right to participate in the development of new European standards. PSBs are in turn obliged to adopt those European standards they have co-developed. The PSB concept was introduced in 2005 and allows CEN to expand the domain of European standards and consequently, the Internal Market beyond EFTA and EU member states. PSBs at the same time harmonize their standards repositories in accordance with the EU repository and provide domestic businesses with an improved access to the Internal Market. Presently, standards bodies from Egypt, Russia, Serbia & Montenegro, Tunisia and Ukraine have PSB status.

3.1.10 Similar processes for producing standards

There are not only structural but also procedural similarities between CEN, CENELEC and ETSI. This is especially true for the respective standards production processes. However, a close examination of the procedures would be going much too far at this point and will be omitted. See for example the Internet on CEN production processes and the respective flow-charts/graphical representations, the respective Internal Regulations/Rules of Procedure for details, and Schepel and Falke (2000) for a detailed account of standardization procedures in the ESS.

3.1.11 Coordination of standardization work

Given the convergence of various technologies, overlaps in the respective working fields become inevitable and call for a closer coordination of CEN, CENELEC and ETSI activities. The basic co-operation agreement between CEN, CENELEC and ETSI of 31 July 2001 aims for example 'to prevent duplication of work, to identify any gaps in the work programmes, to maximize the efficient use of scarce resources, and to clarify responsibilities'. CEN, CENELEC and ETSI may dispatch to each other 'liaison officers' who take part in meetings of specific Technical Bodies and provide for the exchange of information. Joint Working Groups and Joint Technical Committees may be set up if necessary.

The basic principle of cooperation between ESOs, the Commission and EFTA is laid down in the General Guidelines for Cooperation between CEN, CENELEC and ETSI and the European Commission and EFTA of 28 March 2003 (OJ 2003/C 91/04). The Framework Partnership Agreement 2004-2007 especially addresses financial matters. The most prominent manifestation of CEN's, CENELEC's and ETSI's coordination efforts is the Joint Presidents' Group (JPG). It provides a forum in which not only standardization activities are coordinated but virtually all issues of common interest are discussed. The JPG is made up of highest-ranking representatives of ESOs, such as the Secretaries General of CEN and CENELEC and the Director-General of ETSI. For details on the Joint Presidents' Group (See http://www.cenorm.be).

3.1.12 Support of EU policies

In their statutes and mission statements, CEN, CENELEC and ETSI emphasize their close relationship with the EU and EFTA organs. CEN, CENELEC and ETSI support general EU goals such as the advancement of the European economy and European competitiveness, the completion of the Internal Market, and the creation of a 'sustainable society' (CEN Annual Report, 2005). Furthermore, CEN, CENELEC and ETSI play a vital part in the New Approach and actively support the corresponding regulatory goals, such as 'safety of workers and consumers, interoperability of networks, environmental protection, exploitation of research and development programmes, and public procurement.'

Under the New Approach the Commission asks for the preparation of European standards and provides funding for such and other standardization activities it considers relevant. CEN, CENELEC and ETSI thus depend on EU funding. The support of EU policies compromises the primacy of international standardization to some degree: international standards are adopted as European standards only as long as they do not conflict with fundamental EU goals and policies.

The portion of international standards in the CEN and CENELEC repositories is nevertheless relatively high: 27% of the CEN repository is identical to ISO standards, while 57% of the CENELEC repository is identical to IEC standards (Kelly, 2005).

3.1.13 Similar deliverables

CEN, CENELEC and ETSI offer a whole array of similar deliverables:

- European standards ('EN') are adopted by CEN, CENELEC and ETSI and have to be implemented as identical national standards, while any conflicting national standard has to be withdrawn (CEN/CENELEC Internal Regulations, Art. 2; ETSI Rules of Procedure, Art. 13). Harmonized standards are European Standards that are prepared under the New Approach regime (Commission, 2000, Chapter 4.2). In 2004, for example, 30.17% of all CENELEC standards and 16.70% of all CEN standards were prepared under the New Approach regime (CENELEC Annual Report, 2004, 20, CEN Annual Report 2004-2005, 22).
- CEN and CENELEC Workshop Agreements Workshop Agreements ('CWA'). The CWA-concept is portrayed below.
- Technical Specifications (CEN TS, CENELEC TS, and ETSI TS) are Normative Documents which have been approved by a Technical Committee but have not yet been fully approved by the respective ESO. A Technical Specification may be called an intermediate standard which lacks the legitimacy of a 'regular' standard, but can be published much faster, however, and often addresses new or experimental technologies. To be published, Technical Specifications should not be in conflict with European standards.
- Technical Reports (CEN TR, CENELEC TR, and ETSI TR or ETSI Special Reports), as well as ETSI Guides and CENELEC Guides serve primarily informational and referential purposes.

For details on CEN, CENELEC and ETSI deliverables see the respective Annual Reports, Statues and web resources. Fast delivery of Normative Documents is presumably the most pressing issue for standards bodies at present - especially with regard to the increased relevance that consortia have in contemporary standards preparation. CEN and CENELEC Workshop Agreements ('CWA') are relatively young deliverables which are in the first place designed to reduce 'time to market' and to bridge the gap between formal standards and consortia standards, which usually exhibit no or only limited legitimacy.

CEN and CENELEC Workshops are designed to 'emulate' consortia-style standards preparation and exhibit the following features:

- CEN and CENELEC Workshops can be set up more easily and operate less formally than 'regular' standards projects.
- Access to Workshops is not restricted to actors of European origin.

- Workshop participants work and decide independently on a given work item. CEN and CENELEC provide professional support and infrastructure but do not interfere with decision making in the workshop. CWAs should, however, not conflict with existing European standards.
- Not all interested or affected parties need necessarily be involved in the preparation of a CWA.
- The strict consensus principle is abandoned in order to accelerate decision making.
- A public enquiry stage does not exist.
- Lacking the legitimacy of European standards, CWAs do not support New Approach legislation.
- CWAs have a rather short half-life but may be easily promoted to become regular standards.

3.1.14 Similar basic problems and challenges

- CEN, CENELEC and ETSI face the pressure to realign structures and procedures in order to adapt to changes in their environment (e.g. accelerated technical progress, shorter product life cycles, and new communication and information technologies) and to meet the increasing demands of stakeholders in standardization - especially with regard to the timely provision of standards.
- CEN, CENELEC and ETSI face the global economy, newly evolving players, increasingly complex interdependencies, and tougher competition.
- With regard to increased internationalization, regional standards Bodies have to permanently reconsider and redefine their intermediate position between the national and international level of standardization.
- The reliance on the above-mentioned principles of standardization brings with it a conflict of objectives: reaching consensus in standardization processes requires sufficient time while the demand for accelerated standards production has increased sharply. Furthermore, in consensus-based standardization, an agreement on a specific standard is not guaranteed. Timely delivery of standards and normative documents is one of the main issues for standards bodies in general.

3.1.15 Common answers to a set of common problems and challenges

- CEN, CENELEC and ETSI increasingly rely on modern management techniques, communication technologies and electronic decision-making tools to shorten standards preparation time and avoid friction in the production process.
- As shown above, CEN, CENELEC and ETSI engage in far-reaching cooperation and extensive networking with various relevant stakeholders and actors. These relationships can take a variety of forms which may, however, be subsumed under the slogan 'cooperation instead of competition'.
- CEN, CENELEC and ETSI nevertheless emphasize the strategic relevance of standardization as such, their rather service-oriented approach, and their strong business and market orientation.
- CEN, CENELEC and ETSI offer deliverables which meet a variety of demands. Especially relevant are those deliverables which can be produced at a faster speed than regular European standards and significantly reduce 'time to market'. Faster delivery is the result of a departure from some basic principles of standardization - especially from the rather time-consuming consensus principle.

3.2 Differences between CEN, CENELEC and ETSI

3.2.1 Historical aspects

As seen in Section 2.1, CEN and CENELEC's ancestors, CENEL and CENELCOM, were founded in the late nineteen-fifties/early nineteen-sixties. In 1973, CENELCOM and *European Committee for the Coordination of Electrical Standards* (CENEL) merged to become CENELEC. In 1975 CEN - until then located in Paris and associated with AFNOR - moved to Brussels and became a non-profit organization under Belgian law and an independent legal entity (Falke and Schepel, 2000, 3). 1975 is regarded by CEN officials as CEN's factual year of birth (CEN, 1995). CEN and CENELEC, however, operated more or less independently of each other from the outset and still differ in culture. The relationship between the two bodies took a 'structured und continuous form' with the CEN and CENELEC co-operation agreement in 1982 after the failure of the Old Approach had become apparent (CEN, 1995, 20). CENELEC appeared in 1973 on EC radars as a possible partner to bring the Low Voltage Directive to life, while CEN was acknowledged only ten years later in the Information Directive.

CENELEC adopted Weighted Voting Methods much earlier and could therefore make decisions comparatively faster than CEN, which relied on the 'one country, one vote' principle until the nineteen-eighties. The early adoption of Weighted Voting presumably contributed to CENELEC's early liaison with the EC. A common problem to CEN and CENELEC was, however, that the purpose of European standards bodies and their relations to existing standardization structures were frequently called into question even by CEN and CENELEC members (CEN, 1995, 20). In particular, the advent of CEN on the standardization scene was met with scepticism by non-European ISO members like the USA. ETSI in turn was founded in 1988 and is relatively young compared to CEN and CENELEC. The foundation of CEN and CENELEC's ancestors was to some degree motivated by political considerations, but largely based on private initiatives. ETSI's foundation, however, was largely a regulatory measure initiated in the first

place by EU organs (see e.g. Hawkins, R. (1995) and the Commission Green Paper on the development of the Common Market for telecommunications services and equipment (COM (87) 290, June 1987)). It was the Commission's intention to challenge CEN's and CENELEC's country model and to transfer ETSI's institutional attributes to CEN and CENELEC. This measure should have resulted in a more efficient and competitive ESS, but, as shown in this chapter, some significant differences persist. This implies that the Commission could not fully realize its ambitious plans to reshuffle the ESS. See also Chapter 4 of this module.

3.2.2 Institutional aspects

CEN's working field is much broader than those of CENELEC or ETSI. CEN covers literally every standardization activity that is neither electrotechnology nor telecommunication by nature. To cope with such a broad working field, CEN's technical organization is sectorally structured. From a historical and institutional point of view, standardization structures have usually been established faster in electrotechnology (and telecommunications) than in other technical fields. The diffusion of electrotechnical innovations crucially depends on networks and the underlying standards which constitute the respective networks. Due to its inherent safety risks, the diffusion of electrotechnology soon raised the issue of appropriate safety standards. Thus the benefits (or the necessity) of standardization became evident earlier in electrotechnology during the industrial revolution than in other fields. IEC was founded in 1906, while ISO, i.e. ISO's predecessor, the International Federation of the National Standardizing Associations (ISA), was established in 1926. This is also the case with the European standards bodies, as CENELCOM started work earlier than CEN and introduced weighted voting methods earlier than CEN. Telecommunication builds on electrotechnology and therefore constitutes a technological layer on a higher level. One would therefore expect similar dynamics with regard to standardization processes in both fields.

Different members (albeit similar membership categories)
As seen before, CEN's, CENELEC's and ETSI's membership categories exhibit a number of similarities. The actors allowed for membership, however, differ: CEN allows for the membership of national standards bodies of EU and EFTA origin. Analogously, CENELEC allows national electrotechnical committees of EU and EFTA origin to acquire full membership. In the case of CEN and CENELEC, individual actors such as companies are not entitled to take part in standardization work directly. Rather, as seen before, a national position on specific issues and work items is formed in mirror committees set up by NSBs and put forward by national delegations dispatched to CEN or CENELEC. ETSI, however, allows individual European actors such as producers, vendors, users, administrations and standards bodies to gain direct membership. ETSI generates large

portions of its income with comparatively high membership fees but gives away its Normative Documents free of charge while standards produced by CEN and CENELEC are sold. The reader may note that the ETSI General Assembly switches over to a 'national voting mode', as soon as important institutional issues and European standards are on the agenda. In this case, national delegations of EU and EFTA member states cast votes according to a Weighted National Voting Procedure. This voting method strongly resembles those methods applied by CEN and CENELEC, as direct participation in important and genuine European matters is 'switched off'. For details see ETSI Rules of Procedure, Article 11.

3.2.3 Success stories of European standardization, notable projects and activities

The success of the European approach to standardization is by and large measured by the success that standards activities and European standards have in terms of performance and user acceptance. Of course, it is only possible to give a few examples within the framework of this module. The slight imbalance towards ETSI in this chapter is rather accidental and is not intended to imply that CEN and CENELEC are less successful than ETSI. Of course, there have also been failed initiatives and standards projects in the history of European standardization. CENELEC's initiative to harmonize domestic plugs and socket outlets in Europe, for example, succumbed to vested national interests (see e.g. COM(1998) 291, 3, and CENELEC, 1999, 5). See also Vardakas (2003, 7) on successes and problems of the NA.

eEurope
The eEurope initiative was launched by the Commission in 1999 as part of the Lisbon Strategy to fully exploit the chances the information society has to offer (Commission 1999). A prominent role in this endeavour was assigned to the ESOs from the outset, which set up a rolling Action Plan in response (CEN Management Centre, CENELEC Secretariat and ETSI Secretariat, 2002). The first stage, the eEurope 2002 programme, aimed, for instance, at 'equal access to the benefits of the information society' for all EU citizens, the 'promotion of computer literacy', and to accomplish this in a socially inclusive, not divisive manner. The second stage, the eEurope 2005 programme, 'focuses on providing a widespread availability of broadband access, a secured information infrastructure, and the development of online public services and e-business applications' (ETSI portal on eEurope, COM(2002) 263 final).
Examples of policy fields of interest within the eEurope initiative are e.g. broadband issues, e-Learning, e-Government, e-Health, e-Business, e-Inclusion, Digital Rights Management, and Trust. In each of these fields, standardization playsa fundamental role. On the state of affairs see the eEurope 2005 website. The successor to the eEurope initiative will be 'i2010 - A European Information Society for growth and employment'. i2010's aims include the completion of a

Single European Information Space, increased innovation and Investment in ICT research, and an 'inclusive European Information Society' by the end of 2010 (COM(2005) 229 final). For further information on this initiative see the EU i2010 website.

Accessibility, e-Accessibility
CEN, CENELEC and ETSI made remarkable efforts to address the issues of Accessibility and e-Accessibility, the latter of which is an element of the eEurope initiative. See 'CEN, CENELEC, and ETSI: Success stories in European Standardization' for details.

Global System for Mobile Communications (GSM)
The Global System for Mobile Communications (GSM) is without doubt a true success story of European standardization. ETSI actively takes part in the development of successive standards and technologies such as Digital Enhanced Cordless Telecommunications (DECT) or Universal Mobile Telecommunication System (UMTS). See Pelkmans, J. (2001) for a detailed account of the factors that contributed to the success of GSM. Pelkmans also illustrates that a well-devised policy approach can indeed help to overcome obstacles in the private sector and to successfully introduce standards and/or technological innovations. See the ETSI Annual Report 2004 for further notable ETSI projects.

Successful CEN and CENELEC standards
CEN (1999) points at a number of successful standards in various fields, for example:
- EN 71 - Safety of toys.
- EN 197 - Cement.
- EN 13235 - Advanced technical ceramics.
- EN 1836 - Sunglasses.
- EN 1948 - Sampling of dioxins and furans from waste incineration.

The reader may note the variety of technical fields covered by these few examples, some of which have a significant impact on the daily life of every EU citizen. CENELEC for example points at its successful activities (CEN, CENELEC, and ETSI, 2004, 6):
- In the field of Electromagnetic Compatibility (EMC), and in accordance with the corresponding European Directive no less than 250 successful standards have been published in over 25 years.
- In the Field of Medical Devices, and in accordance with corresponding European Directives, CENELEC has published more than 100 standards, which fulfill the minimum requirements set by Directives.
- Once again in accordance with EU policy initiatives, CENELEC plays an active part in standardization in the field of Interactive Digital Television.

3.3 The relationship between European standardization and international standardization

The relationship between ESOs and their international counterparts (ISO, IEC and ITU) is especially close. As seen in Section 3.1, EU organs and ESOs acknowledge in accordance with the WTO Agreement on Technical Barriers to Trade/WTO Code of Conduct the primacy of international standardization. CEN for instance not only supports the 'world-wide standardization in the International Organization for Standardization', but also promotes the 'uniform implementation of International Organization for Standardization (ISO) and other international standards or recommendations by CEN members' (CEN Internal Regulations). The mode of cooperation between CEN and ISO is laid down in the so-called 'Vienna Agreement' which saw its latest revision in September 1998. CENELEC and IEC signed a similar document in September 1996 usually referred to as the 'Dresden Agreement'.

Both agreements have similar aims:
- Efficient allocation of tasks and resources.
- Avoidance of duplication of work.
- Coordination of procedures to accelerate standards preparation ('Parallel Voting').
- Simplified promotion of European standards to the international level.
- Simplified 'download' of international standards to the European level.

ETSI and ITU-T, the standardization branch of ITU, signed a Memorandum of Understanding in May 2000 similar to the Vienna and Dresden Agreements. The EU's attitude towards international standardization is outlined in the Commission Staff Working Paper on European policy principles on International Standardisation (SEC(2001) 1296).

Some of its elements are as follows:
- International standards are basically regarded as beneficial, as they promote free and fair trade, open market access, and the dissemination of technologies on a global scale (SEC(2001) 1296, 4). Standards can, to some degree, substitute hard-wired laws and regulations.
- However, international standards may in some areas, such as safety, consumer and environmental protection, be unfit to meet legitimate regulatory aims on the national or regional level. The EU therefore reserves the right to rely on European standards, should some regulatory aims not be adequately supported by international standards (SEC(2001) 1296, 5). (This right is granted to each WTO member under the TBT Agreement.)
- An international standard that is to be used on the national or regional level for regulatory purposes should exhibit a sufficient degree of legitimacy (SEC(2001) 1296, 6).

International standardization should especially assist Third Countries as standards are an effective instrument to build up a functioning infrastructure.
- The Commission advocates the European Approach to standardization as an institutional blueprint for national, regional and international standardization infrastructures.

The reader may note something like role ambiguity with regard to CEN and ISO (CENELEC and IEC): standards bodies of EU and EFTA member states are members both of CEN (CENELEC) and ISO (IEC) and sit on both sides of the table, when CEN (CENELEC) and ISO (IEC) representatives meet to design their mutual relationships. Furthermore, standards bodies of EU and EFTA member states influence proceedings in ISO and IEC directly as Full Members; but also indirectly via CEN and CENELEC. The Commission asks Member bodies of the ESS with regard to the direct participation on the international level 'that national positions should be coherent with European policies and legislation, if existing' (SEC(2001) 1296, 6).

4 EU standardization policies after the introduction of the New Approach

From the historical point of view, Chapter 2 of this module stopped short at the beginning of the nineteen-nineties. At this time the basic elements of the New Approach and that of the Global Approach had been established. Although the New Approach remains largely unchanged until the present time, EU organs induced (or at least proposed) some significant modifications to the ESS, which will be outlined in this chapter. In Section 4.1 the present state of affairs and especially the present attitude of EU organs towards standardization and the New Approach in particular will be addressed. Section 4.2 deals with notable initiatives that EU organs have launched since the beginning of the nineteen-nineties. Section 4.4 deals with some notable recent trends in the EU policy on standardization and Chapter 4 summarizes some stylized facts and statements on the EU standardization policy that easily disappear from view in the heat of the debate. Of course it is beyond the scope of the module to give a full account of all EU policy initiatives in the field of standardization that have been launched after the NA came into effect. Instead, emphasis is put on the most important and recent events, and the corresponding documents.

4.1 The present attitude of EU organs towards European standardization

The present attitude of EU organs towards the ESS and consequent policy recommendations are presumably summarized best in the Council Conclusions on European standardisation of 21-22 December 2004 (Document 14790/2/04 REV 2, see also COM (2004) 674 final of 18 October 2004):
- The use of European standardization in support of EU policies and legislation should be intensified.
- European standardization should be applied as a policy instrument in new areas, such as 'services, ICT, transport, consumer and environment protection'.
- Standardization awareness has to be increased especially among business leaders.
- The participation of the business community in the standardization process should be facilitated. This particularly applies to SMEs.
- The given legal framework of European standardization should be reviewed and streamlined in order to adapt the regulatory package to the latest developments and challenges, such as the enlargement of 2004 or the Internal Market Priorities 2003-2006 (COM (2003) 238 final).
- The funding of the ESS shall be put 'on a solid legal basis'. Both the EU and member states shall take a fair share in the funding of standardization activities.
- European standards bodies shall be supported in streamlining the standardization process.
- The primacy of international standards and standardization is once again stressed with regard to global market access and international trade.

Some further points that illustrate the attitude EU organs hold towards the ESS:
- In principle, EU organs regard standardization as an instrument of sustainable development (General Guidelines 2003). 'Sustainable Development' is a key term - not only for the United Nations (http://www.un.org/esa/sustdev/), but also in EU politics. See the Commission's website on Sustainable Development.
- EU organs have always been eager to support NGOs in putting forward their legitimate interests in European standardization - especially in the fields of consumer protection, protection of workers and environmental issues. Presently, NGOs are showing increased interest in European standardization and have better access to ESOs than ever before. The EU for example strongly supported the foundation of the 'Association for the Co-ordination of Consumer Representation in Standardisation' (ANEC).

- ANEC is conducting its own research in the field of consumer safety and actively takes part in standards preparation on the European and international level. ANEC also monitors and assesses standardization policies adopted by ESOs and does not hesitate to voice critique from the consumer's point of view, if considered necessary. See e.g. ANEC Newsletter Number 74 - October 2005.

4.2 Elements of EU standardization policies

4.2.1 The foundation of ETSI

The most dramatic intervention to the ESS came rather early in 1988 with the foundation of ETSI. In its Green Paper on the development of the Common Market for telecommunications services and equipment (COM (87) 290, June 1987), which anticipated a number of trends fairly well, the Commission outlined the need to fundamentally restructure the European telecommunications sector. The Commission especially proposed the creation of a European Telecommunication Standards Body which was to take over standards preparation from the European Conference of Postal and Telecommunications Administrations (CEPT) and produce genuine European telecommunications standards. The foundation of ETSI implied a significant shake-up to the already well-established CEN/CENELEC-System. ETSI, as seen before, has exhibited a number of institutional attributes from the outset that are significantly different to those of CEN and CENELEC. CEN and CENELEC consequently welcomed the arrival of their new stepsister with scepticism (Hawkins, R., 1995).

4.2.2 Early EU suggestions for improvement of the ESS

EU organs started to review the progress made with the ESS and the NA at a very early stage and suggested improvements to the system. In its Green Paper on the development of European standardization (Commission 1990), and with regard to the projected completion of the Internal Market in 1992, the Commission identified the need to dramatically speed up the production of European standards and made some far-reaching suggestions to reorganize the ESS accordingly. Some of these suggestions have been repeated frequently by EU organs ever since, while other initiatives succumbed to the resistance of the standards community and were silently buried.

The Commission made the following suggestions in its Green Paper, among others:

- With regard to the completion of the Internal Market, the production rate of European standards should be increased and the standardization process accelerated. To this end, the Commission proposed a number of technical and organizational measures. See Commission (1990, 19) for details.
- The ESS as a whole should be fundamentally restructured (Commission, 1990, Annex 2). In a significant step towards centralization a 'European Standardization Council' should have become the highest organ in European standardization, responsible for the 'strategic direction' the ESS should take. A 'European Standardization Board' should have been the highest executive organ within the ESS, to which ESOs would have been subordinated. Furthermore, ESOs were asked to realign structures towards a sectoral approach in standardization and to allow for greater direct participation of individual stakeholders.
- The Commission called for stronger engagement of European stakeholders in European standardization. European industries, in particular, should participate actively in European standardization. Adequate financial support and professional input from those quarters were regarded as indispensable for the creation of a genuine internal market.

The ambitions pursued with the Green Paper were significantly scaled down in subsequent consultations with the standards community, which particularly refused to give up the principle of national delegation. In its Communication of 27 October 1992 on Standardisation in the European Union (Follow-up to the Commission Green Paper of October 1990, COM(92)445) the Commission acknowledged the institutional shape the ESS exhibits today - including a rather flat hierarchy with a rather non-hierarchical Joint Presidents' Group as the highest coordinating body. See Woeckner (1997) for an assessment of the situation in the early nineteen-nineties.

4.2.3 The EU notion of efficiency and accountability

'Efficiency' and 'accountability' are two key words frequently used in EU documents on standardization. The Commission Report on Efficiency and Accountability in European Standardization under the New Approach (COM(1998) 291) is the related key document in which these terms and policy recommendations are specified:

Accountability
Standards that are to be used for regulatory purposes have to meet certain criteria to be sufficiently legitimate (COM(1998) 291, 4): The standardization process has to be open and transparent. The standard as such has to be supported by all major interested parties and has to be applied uniformly over the whole Community. Each interested party must be given the opportunity to

consider and comment on a draft. Given the criteria associated with the notion of accountability, the use of Publicly Available Specifications (PAS) in the context of the NA (or other regulatory purposes) is limited (COM(1998) 291, 5). PAS may, however, be used as an input to the 'regular' standardization process.

Efficiency

Efficiency implies the production of high-quality standards in a 'timely fashion' that meet the demand of interested parties (COM(1998) 291, 6). This sounds familiar, but the Commission's notion of efficiency goes beyond these plausible criteria: in the context of the NA a standard is regarded as efficient if it meets the Essential Requirements laid down in the corresponding Directives. The Commission proposes a number of measures to speed up the production process of standards. The procedures related to the NA, according to the Commission, are indispensable elements that afford a minimum time. Furthermore, the Commission adopts a rather sceptical stance on the wider application of weighted voting procedures in the standardization process, and argues that these methods compromise the criteria of accountability - without necessarily increasing production speed. The Commission furthermore asks CEN and CENELEC (once again) to allow workers, consumers, environmental interests and industry for greater participation. With regard to the quality of standards, the Commission asks for intensified pre-normative research. Some of the demands and proposals, especially the notions of efficiency and accountability, appear to be rather contradictory. The inclusion of additional stakeholders/interested parties conflicts with the demand to shorten standards preparation time. Although efficiency and accountability should basically be balanced, efficiency may be compromised in favour of accountability (COM(1998) 291, 4). See also Falke and Schepel (2000, 21) on the contradictory nature of some recommendations made by EU organs on the standardization issue.

4.2.4 The applicability of the New Approach and consensus-oriented decision making in policy fields other than standardization

During the mid-nineteen-nineties standards production with regard to the Internal Market gathered pace, and EU organs began to feel satisfied with the ESS's performance under the NA. In its Communication to the Council and the European Parliament on the broader use of standardization in Community policy (COM(95) 0412) the Commission still critically assessed the difficult relationship between 'soft' voluntary standardization and 'hard' regulatory and legislative aims, but already considered the applicability of the NA and 'standardization-style' consensus-oriented decision making in fields other than standardization.

The NA is now regarded by EU organs as a good example of 'Better Regulation' which reaches a given regulatory aim while avoiding 'regulatory overkill' and minimizing associated administrative monetary and social costs (e.g. in terms

of coercion exerted on parties affected). See the Commission Communication on Better Regulation for Growth and Jobs in the European Union (COM(2005) 97), the Commission Communication on Implementing the Community Lisbon programme - A strategy for the simplification of the regulatory environment, COM(2005) 0535 final, and also Commission web-site on Better Regulation.
Furthermore, the NA is regarded by EU organs as fit to be applied in policy fields other than standardization. Wilkinson of the Enterprise Directorate General puts it the following way: 'Arguably, any entrepreneurial activity operating within the Internal Market could adopt the New Approach, as long as the public interest is adequately protected'. And even more directly in her conclusion: 'The New Approach can go - anywhere' (Anne Wilkinson, 2003: The Future of the New Approach. Enterprise Seminar 11 February 2003).

4.3 EU enlargement and European standardization

ESOs are avant-garde with respect to the integration of acceding countries and candidate countries, as the first steps of economic, technological and structural integration usually take place on the level of standardization. Standards bodies of prospective member states of Central and Eastern Europe that are willing to adopt the European standards repository and to integrate in the ESS are granted the status of Affiliates. Affiliates are given the right to take part in the General Assembly and in Technical Bodies of ESOs and to receive all relevant technical and administrative information. Long before the accession of a prospective member state is completed on the political level, integration had already gathered pace thanks to the adoption of European standards and integration into the ESS.

4.4 Recent trends in European standardization

(European) Standardization with its close relations to virtually all fields of technology is regarded as a most capable instrument for providing significant stimuli for recent EU policies. See Ayral (2005). European standardization is for example given a no less than outstanding role in the revived Lisbon strategy.

New standardization initiatives are supposed to trigger new activities, progress and growth e.g. in the following innovation-prone technology fields (see the Commission's Action Plan for European Standardization, October 2005):

- Space standardization, especially with regard to the Galileo project, the European Ground Positioning System.
- Defence, to improve the interoperability between European armed forces and to increase the competitiveness of the European defence industry.

- Evolving new fields of research such as nanotechnologies, hydrogen and fuel cells (renewable energy sources).
- Security, which has become a significant new issue in standardization with regard to threats such as natural disasters and global terrorism.

Two issues that EU organs are presently putting strong emphasis on are environmental policies and the service sector, i.e. the liberalization of services across the EU. It should come as no surprise that European standardization is once again assigned a significant role in both EU policy fields. It is for instance within the Framework of the European Strategy for Sustainable Development, outlined in COM (2001) 264 final, that the Commission pursues 'the integration of environmental aspects into the European standardisation process'. An additional substantial element of the EU approach to environmental issues is the 'Integrated Product Policy' which the Commission proposed in its 'Green Paper on Integrated Product Policies' (COM (2001) 68 final). However, according to the Green Paper, environmental aspects are still underrepresented as European standards are in the first place designed to address usability and safety issues. The Green Paper therefore proposes the 'greening of standardization' (Green Paper, 2001, 21) and to give environmental aims, i.e. the notion of 'environmental soundness' (Green Paper, 2001, 20), the prominence in European standardization that safety aims and usability aspects already have. The standardization activities in the field of services on the European level that are presently gaining momentum are indeed directly related to the EU initiative to create a Common Market for services (Commission 2005, M371 EN). For CEN's current activities in the field of services see the Internet and especially the related work programme. As seen above, another prominent policy issue where European standardization plays a significant role is the 'accessibility for all' initiative which aims at the unimpeded access to modern information technologies for all EU citizens of all ages and all social groups. See Rosenbrock (2003) for an introduction to this issue. According to Ayral (2005, 7), standards have successfully substituted hard-wired legislation in this field.

4.5 Some stylized facts and statements on the New Approach

Both in the public and scientific discussion some basic but nevertheless important facts on the EU approach to standardization are occasionally lost sight of. This in the first place is due to the complex structure of EU institutions and policies and the different, sometimes selective, perspectives that different scholars and interest groups have on European standardization.

Some of these basic albeit important facts on EU standardization policies are as follows:

- The EU standardization policy is not necessarily confined to the NA. EU organs are basically free to take different, especially more robust approaches to standardization. This may include a return to Old-Approach-style policies. EU organs may for example bypass ESOs and issue directly mandatory technical specifications in the form of hard-wired legislation. See e.g. COM(1998) 291 final.
- At the same time, the NA covers only parts of the European standards repository and standardization activities, i.e. there are areas unregulated by the NA. This in turn implies that ESOs are free to pursue standards projects that are beyond the NA domain.
- The relationship between EU organs and ESOs is basically mutual and cooperative. Standardization is without doubt a policy instrument for EU organs. But its use/application is usually the result of close consultations with standards professionals from the ESO. ESOs are therefore not only subject to but in fact have a significant influence on EU standards policies.
- ESOs are formally independent of EU organs. ESOs, in particular, can reject EU mandates. However, rejection of an EU mandate will usually be based on plausible arguments, e.g. technical viability. ESO will normally accept EU mandates and the financing that comes with it, although the proper transformation of a mandate or directive may occasionally impose some problems.
- The NA represents one instrument in the regulatory toolbox that the EU has at its discretion. What originates as hard-wired law in the form of Directives comes to bear in the form of (technical) standards, which represent a rather soft form of law. In this respect the degree of coercion as perceived by the relevant actors appears to be relatively weak.
- The EU acknowledges that consortia can to some degree be regarded as competitors to 'classical' standards bodies and may provide an appropriate approach to standardization when production speed is crucial and public interest not affected. (See SEC(2001) 1296, 9).

5 Concluding remarks

The New Approach is proudly presented by EU organs as an exponent of the 'better regulation' initiative (see e.g. the Communication of the Commission 'Implementing the Community Lisbon programme - A strategy for the simplification of the regulatory environment' COM/2005/0535 final), has been hailed as a success story and is even regarded as fit for application in policy fields other than standardization (Council Resolution of 28 October 1999 on the role of standardisation in Europe (2000/C 141/01)): '...the New Approach created for the completion of the internal market, which combines the official instrument

of the Directive with voluntarily applied European standards, has proved itself and should be further applied, and invites the Commission to examine systematically whether the New Approach principle can be applied to sectors not yet covered as a means of improving and simplifying legislation wherever possible'. Indeed, the European approach to standardization has been successful so far. With minimum regulatory intervention, minimum coercion, and strong reliance on private actors, their initiative and support, EU standards policies have made a major contribution to the Internal Market project and may well serve as a blueprint for other countries or regions. EU standardization policies are by no means laid to rest in the sense that a sufficient European standards repository in support of the Internal Market project is only kept in a 'dynamic equilibrium', i.e. properly maintained. Rather, as the Action Plan for European Standardisation of October 2005 suggests, European standardization plays a pivotal role in the revived Lisbon strategy and is supposed to have an influence within the most advanced fields of technology. To this extent, (European) standardization is obviously still regarded as one of the most capable instruments for shaping societies on the technological, infrastructural and economic level. Furthermore, the New Approach serves as a blueprint on the WTO/TBT-level (Vardakas 2003, 7). Of course, there are still some issues to tackle in the field of standardization. The CE-Marking approach, for example, has not fulfilled expectations and is under criticism from various quarters. Given the enormous speed of innovation in many technological fields and the competition staged by consortia, the 'classical' approach to standardization is under remarkable pressure. Furthermore, there still exist some contradictions which induce slight tensions: given widespread internationalization and globalization, for example, what should be the position of a regional standardization system? Eventually, EU VIPs, high-ranking industry representatives and standardization community representatives had many good reasons to celebrate the 20th Anniversary of the New Approach on 30 November 2005 in Brussels.

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7 Glossary

Accreditation
Procedure by which an authoritative body gives formal recognition that a body or person is competent to carry out specific tasks. ISO/IEC Guide 2:2004, EN 45020:1998, 12.11(CEN/BOSS Glossary: http://www.cenorm.be/BOSS/glossary.asp)

Barriers to the free movement of goods, Technical Barriers to Trade
Technical regulations and product standards may vary from country to country. Having many different regulations and standards makes life difficult for producers and exporters. If regulations are set arbitrarily, they could be used as an excuse for protectionism. The Agreement on Technical Barriers to Trade and EU Internal Market policies try to ensure that regulations, standards, testing and certification procedures do not create unnecessary obstacles.

Better regulation
Commission initiative "to ensure that the regulatory environment is simple and of high quality." It consists of three elements: withdrawal or modification of pending proposals, simplification of existing EU law, an better quality of new Commission proposals (European Commission: http://europa.eu.int/comm/enterprise/regulation/better_regulation/index_en.htm)

CE Mark
CE stands for Conformité Européen (European Conformity). The CE mark - also CE conformity mark - indicates that - according to the manufacturer/importer - a product complies with the requirements of the relevant New Approach

Directives. Therefore, to a certain extent, the CE mark functions as a 'passport for the free movement of goods in the EU'. In the case of products that are covered by a number of Directives, the CE mark indicates that the requirements of all the Directives concerned have been met. Each Directive lists the conditions that have to be observed in CE marking. The manufacturer/ importer bears the responsibility for affixing the CE mark after the requirements have been fulfilled. N.B.: The CE mark is a sign of conformity with Directives and not a quality mark or standards conformity mark.

Commission of the European Union
Body with far-reaching control & compliance powers. The Commission is made up of 25 commissioners (one from each member state). Each Commissioner is assigned a specific policy area. The Commission - often called the "driving force" of European integration - is the only EU body entitled to propose legislation. The Commission is supported by administrative bodies, the Directorates-General.

Conformity assessment
Any activity concerned with determining directly or indirectly that relevant requirements are fulfilled. Typical examples of conformity assessment activities are sampling, testing and inspection; evaluation, verification and assurance of conformity (supplier's declaration, certification); registration and approval as well as their combinations. (ISO/IEC Guide 2:2004, EN 45020:1998, 12.2, CEN/ BOSS Glossary: http://www.cenorm.be/BOSS/glossary.asp)

Consensus
General agreement, characterized by the absence of sustained opposition to substantial issues by any important part of the concerned interests, and by a process that involves seeking to take into account the views of all parties concerned and to reconcile any conflicting arguments. (ISO/IEC Guide 2:2004, EN 45020:1998, 1.7, CEN/BOSS Glossary: http://www.cenorm.be/BOSS/glossary.asp) Consensus need not imply unanimity.

Consortium
Organization that is not formally recognized as a 'promulgator' of public standards, but formed for the purpose of developing common technical specifications for the use of its members, usually in narrowly defined areas. (CEN/BOSS Glossary: http://www.cenorm.be/BOSS/glossary.asp)

Council of the European Union ("Council of Ministers" or "Council")
The Council of the European Union is made up of government ministers and represents the member states' governments. Together with the European Parliament, it decides on legislative and budgetary issues. The Council is the sole decision maker in the fields of common foreign and security policy (CFSP),

and in the coordination of economic policies. The composition of the council depends on its Agenda.

Court of Justice (Court of Justice of the European Communities)
The Court of Justice ensures that Community law is applied equally in each member state. Under Community Law, the Court is entitled to settle legal disputes between member states, EU institutions, companies and individuals.
Each member state provides one judge at present to the 'Grand Chamber', while a Court of First Instance handles technical cases where Intellectual Property Rights and competition issues are disputed. The Court is supported by eight „advocates-general" who publicly and impartially present their opinions on the cases in hand.

eEurope
Initiative based on the Commission communication "eEurope - An Information Society for All", and launched in December 1999. Key objectives are among others to bring the digital age and the information age to Europe, and to support an entrepreneurial culture based on information technology.

Electromagnetic compatibility
Electromagnetic compatibility is the ability of an appliance, an installation or a system to function in an electromagnetic environment without suffering from interference ("immunity"), and without itself causing electromagnetic disturbance that would be unacceptable for other appliances, installations and systems in this environment ("emission"). The following products are examples of those explicitly covered by the EMC Directive (89/336/EEC) and must be designed to meet the EMC requirements:
- radio and television receivers
- domestic appliances
- handheld motor-operated electric tools
- lights and fluorescent lamps
- radio apparatus of all types
- industrial manufacturing equipment
- information technology equipment
- telecommunications apparatus

Essential requirements
Requirements that represent the core of European Union law around which an effective policy has been developed in matters of safety, health and other measures for those areas covered by the 'New Approach Directives'. (CEN/BOSS Glossary: http://www.cenorm.be/BOSS/glossary.asp)

EU enlargement
his term refers to the accession of new countries to the EU. Each country that wishes to join the EU has to meet the so-called Copenhagen Criteria (stable

institutions, democracy, market economy, adoption of the acquis communautaire). Enlargements usually provide both challenges and problems, but also chances and opportunities. In particular, the last enlargement in 2004 was of historic proportions (10 additional member states) and has brought fundamental changes to the EU.

European Community (EC)
The European Community was established by the Treaty establishing the European Economic Community of 25 March 1957 in Rome. It was aimed at the "harmonious development of economic activities", a "continuous and balanced expansion" and "increased stability". To this end, a common (or single) market is to be created. The common market is supplemented by a monetary union ("Eurozone") of 12 (soon 15) member states. The EC constitutes the most important pillar of the EU.

European Directive
Prepared by the European Parliament, the Council and the Commission, "a directive shall be binding, as to the result to be achieved, upon each Member State to which it is addressed, but shall leave to the national authorities the choice of form and methods." (Article 249 (ex Article 189) of the EC Treaty)

European standard
Standard adopted by CEN/CENELEC and carrying with it an obligation of implementation as an identical national standard and withdrawal of conflicting national standards (CEN/BOSS Glossary: http://www.cenorm.be/BOSS/glossary.asp)

European Standardization System (ESS)
The European Standardization System (ESS) comprises the European Standards Bodies (CEN, CENELEC and ETSI), their structural interrelations, and their structural relationships towards the European Union and towards other relevant actors.

European standards organizations
CEN, CENELEC and ETSI, i.e. standards bodies acknowledged by the European Union.

European Union
The European Union is a family of European countries with similar basic values, political systems and common goals. It provides a framework for economic and political co-operation. Its 27 member states have transferred substantial elements of national sovereignty to the EU. The main goals of the EU are prosperity, freedom and the creation of a European identity.

Globalization
Term synonymous with the increased economic exchange and integration and the corresponding far-reaching social changes on a global scale.

Gross Domestic Product (GDP)
Total value of final goods and services produced within a country's borders in a year, regardless of ownership. (Wikipedia: http://en.wikipedia.org/wiki/Gross_domestic_product)

Harmonized Standard, Harmonized Document
Technical specification adopted by European standards organizations, developed under a mandate given by the European Commission and/or European Free Trade Association in support of essential requirements of a New Approach Directive. NOTE: This concept is different from the concept of 'Harmonized standard' used by ISO/IEC and by the 'Low Voltage Directive'. (CEN/BOSS Glossary: http://www.cenorm.be/BOSS/glossary.asp#N)

Industrial revolution
The industrial revolution was the major technological, socioeconomic and cultural change in the late 18th and early 19th century resulting from the replacement of an economy based on manual labour to one dominated by industry and machine-based manufacture. (Wikipedia: http://en.wikipedia.org/wiki/Innovation)

Innovation
Innovation is the implementation of a new or significantly improved idea, good, service, process or practice which is intended to be useful. Scholars who have studied innovation generally differentiate between five main types of innovation: product innovation, process innovation, organizational innovation, marketing innovation and business model innovation. (Wikipedia: http://en.wikipedia.org/wiki/ Industrial_revolution)

Integrated Product Policy
EU approach to environmental issues that aims "to reduce the life cycle environmental impacts of products from the mining of raw materials to production, distribution, use, and waste management. The driving idea is that integration of environmental impacts at each stage of the life cycle of the product is essential and should be reflected in decisions of stakeholders." (COM (2001) 68 final, 5)

Internal Market, Single Market, Common Market.
An internal market is created by the abolition of all internal barriers of trade. This includes the creation of a customs union, the removal of all non-tariff barriers to trade, the free establishment of companies, and the freedom of movement of goods, services, capital and labour.

International standards bodies
These are the international equivalents of CEN, CENELEC and ETSI: the International Organization for Standardization (ISO), the International Electrotechnical Commission (IEC) and International Telecommunication Union (ITU).

Joint Presidents' Group
The Joint Presidents' Group (JPG) provides a forum in which not only standardization activities of CEN, CENELEC and ETSI are coordinated but virtually all issues of common interest are discussed. The JPG is made up of highest-ranking representatives of ESOs, such as the Secretaries General of CEN and CENELEC and the Director-General of ETSI. (CEN: http://www.cenorm.be/boss/organization/profiles+-+index/joint+presidents+group+cen-cenelec-etsi/index.asp)

Lisbon Agenda
The Lisbon Agenda is an initiative agreed upon on by the European Council in a special meeting in Lisbon on 23-24 March 2000. Its aim is to make the EU "the most competitive and dynamic knowledge-driven economy by 2010, capable of sustainable economic growth with more and better jobs and greater social cohesion".

Low Voltage Directive
The Low Voltage Directive of 19 February 1973 (73/23/EEC) covered the free movement of goods operating between 50 and 1000 Volts and incorporated elements which were later applied in the New Approach. It "seeks to ensure that electrical equipment within certain voltage limits both provides a high level of protection for European citizens and enjoys a Single Market in the European Union." (European Commission, http://europa.eu.int/comm/enterprise/electr_equipment/lv/direct/text.htm)

Mandate
Political request from the European Commission (EC) (and European Free Trade Association (EFTA)), agreed upon by the Member States (generally via a decision of the Standing Committee of the Directive 98/34), addressed to CEN, in support of an action from the EC. This can be in support of legislative work such as a Directive (some Directives, not all, are 'New Approach' Directives), or in support of an industrial policy action from the EC. (CEN/BOSS Glossary: http://www.cenorm.be/BOSS/glossary.asp)

Market
A market is a social arrangement that allows buyers and sellers to discover information and carry out a voluntary exchange. (Wikipedia: http://en.wikipedia.org/wiki/Market)

Marshall Plan
Named after United States Secretary of State George Marshall, the European Recovery Program ("Marshall Plan") was the main US contribution to the reconstruction of Europe after World War II. It started in 1947 and was largely received by western European countries because Stalin declined the invitation sent to eastern European countries to take part.

Mirror committee, national mirror
National mirror committees are the "mirror images" of European/International Technical Committees. They ensure the formulation of coherent national positions, provide advice to the NSB on nominations to Technical Committees, comment on drafts and provide the briefings for the delegation and recommendations on voting. (CEN: http://www.cenorm.be/boss/organization/profiles+-+index/cen+national+member/cen+national+member.asp; CEN/BOSS Glossary: http://www.cenorm.be/BOSS/glossary.asp#N)

National delegation
Delegations of experts detached to CEN or CENELEC by NSBs in order to bring to bear a balanced national position with regard to specific work items or management and policy decisions. (CEN: http://www.cenorm.be/boss/organization/profiles+-+index/cen+national+member/cen+national+member.asp)

National standards body
Standards body recognized at national level that is eligible to be the national member of the corresponding international and regional (European) standards organizations. (EN 45020:1998, 4.4.1, CEN/BOSS Glossary: http://www.cenorm.be/BOSS/glossary.asp)

New Approach Directive
European Directive which defines legislative harmonization in a sector where barriers to trade are created by divergent national regulations concerning the health or safety of citizens or consumer or environmental protection. New Approach Directives only lay down the 'essential requirements, conformity with which will entitle a product to free movement within the Community.' (CEN/BOSS Glossary: http://www.cenorm.be/BOSS/glossary.asp)

Non-governmental organization (NGO)
NGOs operate independent of governments. Usually on a non-profit basis, they aim at the improvement of social, cultural, legal, and environmental deficiencies. (Wikipedia: http://en.wikipedia.org/wiki/Ngo)

Non-tariff barriers to trade, technical barriers to trade
All barriers to trade different to tariffs are called non-tariff barriers to trade. This term especially refers to national laws, regulations and indeed standards

repositories which hamper the free movement of goods, capital and services. Technical barriers to trade also belong to the class of non-tariff barriers to trade.

Normative document
Document that provides rules, guidelines or characteristics for activities or their results
NOTES:
1. The term "normative document" is a generic term that covers such documents as standards, technical specifications, codes of practice and regulations.
2. A "document" is to be understood as any medium with information recorded on or in it.
3. The terms for different kinds of normative documents are defined by considering the document and its content as a single entity.
(EN 45020:1998, 3.1, CEN/BOSS Glossary: http://www.cenorm.be/BOSS/glossary.asp)

Official Journal of the European Commission
An official publication of the Institutions of the European Union which is published daily. The 'L series' contains EU legislation (Regulations; Directives etc.), while the 'C series' contains EU information and notices (e.g. summaries of judgments of the Court of Justice or minutes of parliamentary meetings. CEN/BOSS Glossary: http://www.cenorm.be/BOSS/glossary.asp#N)

Old Approach
A term used ex post for the European standardization regime before the New Approach was introduced. To a large extent the Commission tried to draw up standards itself, which proved to be impracticable.

Organization for European Economic Co-operation (OEEC)
The OEEC was founded on 16 April 1948 by 18 western European Countries. Its primary task was to allocate US funds in war-torn Europe and to implement the European Recovery Program ("Marshall Plan"). In September 1961, the OEEC was transformed into the Organization for Economic Co-operation and Development (OECD).

Pre-normative research
"Pre-normative research relates to activities which are likely to generate new matters for standardisation, corresponding to future needs for standards, even if not anticipated early on by the researchers themselves." (CEN: STAR executive summary, http://www.cenorm.be/cenorm/workarea/advisory+bodies/standardization+and+research/summary.pdf)

Presumption of conformity
Assumption made failing proof to the contrary, based on known facts, of the fulfilment by a product, process or service of specified requirements. (CEN/BOSS Glossary: http://www.cenorm.be/BOSS/glossary.asp)

Regulation
Made by the European Parliament, the Council, and the Commission "a regulation shall have general application. It shall be binding in its entirety and directly applicable in all Member States." (Article 249 (ex Article 189) of the EC Treaty)

Service Directive
Abbreviation of the 'Proposal for a Directive of the European Parliament and of the Council on the Internal Market' (Interinstituional File of 10 January 2005). The proposed Service Directive expands the EU harmonization approach from goods to services but met resistance from national governments. It was handed back to the Commission for revision early in 2005 and is presumably going to be passed in a less controversial form.

Single European Information Space
The "Single European Information Space" aims to offer to alle EU citizens "affordable and secure high bandwidth communications, rich and diverse content and digital services." (European Union:http://europa.eu.int/information_society/eeurope/i2010/a_single_infor_space/index_en.htm)

Standardization
Activity of establishing, with regard to actual or potential problems, provisions for common and repeated use, aimed at the achievement of an optimum degree of order in a given context. (ISO/IEC Guide 2:2004)

Standing Committee of a Directive
Committee composed of representatives appointed by the Member States of the European Union (who may call upon the assistance of experts or advisers) and chaired by a representative of the European Commission. It deals with any question regarding the implementation of a Directive, and in particular, gives advice prior to the publication of the references of the national standards retained on a transitional basis and in the case of an appeal procedure provided for by the safeguard clause. (CEN/BOSS Glossary: http://www.cenorm.be/BOSS/glossary.asp)

Sustainable development
A form of economic growth which satisfies society's needs in terms of well-being in the short, medium and - above all - long term. It is founded on the assumption that development must meet today's needs without jeopardizing the prospects for growth of future generations. (Europe Glossary, http://europa.eu.int/scadplus/glossary)

Technical body
Generic term for the Technical Board, or any committee, working group, panel, task force or sometimes, an individual, that has or is assigned responsibilities for technical aspects of standardization within the CEN System. (CEN/BOSS Glossary: http://www.cenorm.be/BOSS/glossary.asp)

Technical harmonization
This term refers to the approximation of national technical laws and regulations and especially of standardization repositories in order to create a genuine internal market.

Unanimity principle
The agreement of all persons involved in a decision over a set of given alternatives. Unanimity is not identical with consensus.

Weighted voting
Voting system applied for the approval of European standards which consists in according specific weightings to votes cast by CEN members.

Work item
Subject with a specific title and scope to be worked out by a Technical Committee within agreed target dates and leading to a CEN, CENELEC or ETSI publication, or a series of interrelated tasks implemented within the constraints of time, cost and quality for the purposes of achieving a specific measurable objective.

8 Key questions

- Why did the Old Approach fail to succeed?
- How do CEN, CENELEC and ETSI coordinate their standardization work?
- What is the significance of the Cassis de Dijon case?
- How can the use of European Standards be voluntary while the underlying EU Directives are obligatory?
- What role does European standardization play with regard to EU enlargement?
- What does "presumption of conformity" mean?
- What are the recent trends in European standardization?
- What are the problems with the New Approach?
- Is the New Approach a success?

Wilfried Hesser

Abstract

A worldwide comparison of the countries where standardization is practised shows that the respective role played by standards and legal requirements varies considerably. Even within one country, there is neither a uniform policy nor are there uniform methods when referring to standards in legal provisions. In addition to this, governmental and private standards-writing organizations often exist side-by-side without any coordination. The resulting confusion of technical rules has detrimental consequences for economic and technical development. This is particularly true in threshold and developing countries, where legislative measures and standards-writing intermingle.

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1 Preface

This unit gives insight into the particular role that technical regulations and legal provisions may assume in a national legal system.
There are a number of conceivable forms in which standards can achieve a binding status, either as a de facto binding force or by references contained in legal provisions. These range from an all-encompassing declaration of the binding effect of standards, on the one hand, to a completely voluntary application, on the other. The following is intended to illustrate this using the hierarchy within the legal system of the Federal Republic of Germany, FRG, as an example. A further section will examine the issue of how standards in Germany are established and monitored.
The fact that a technical standard is legally binding does not mean that it is actually obeyed. If a technical standard is often applied in practice, the more likely it is that reference will be made to its 'de facto binding force'. Various different forms of de facto binding force will be demonstrated, as shown by the safety and basic standards.
Apart from reference to legislation, technical standards my also acquire a legally binding status through their incorporation into agreements made under private law (one example is given by the RAL associations for marks of quality: a company that wishes to affix the mark must join the association and adhere to its statutes). Test marks (such as those awarded by VDE, GS, DIN, etc.) are another way in which legal obligations may arise.

In technical law reference is made to grey legal concepts by means of the so-called blanket clause method. This reference only encompasses the general requirements relating to technical safety, which are only more closely defined in ordinances and administrative provisions.
There is a further differentiation between references to specific technical standards, according to whether they are static or dynamic. Technical standards obtain a more extensive legal significance by statutory regulations that contain references to them. References to technical standards may be found above all in the law concerning safety technology. The State is constitutionally bound to minimize hazards originating from technical equipment and plant, by appropriate statutory regulations, so as to protect the life and health of its citizens. For several reasons, the legislative method of reference to standards has proven to be very effective in this respect.
In Germany, statutory reference to technical standards has a tradition in the law governing safety systems which stretches back over several decades. This will be shown using the Equipment and Product Safety Act (Geräte- und Produktsicherheitsgesetz, GPSG) as an example, together with implementation of the European Directive 2001/95/EC (General product safety).
Finally and very briefly, special mention will be made of the problems of threshold and developing countries in this respect, and the question of whether it is possible to transfer the German and EC approaches to such countries.

2 The status of standards in Germany

A worldwide comparison of the countries where standardization is practised shows that the respective role played by standards and legal requirements varies considerably. Even within one country, there is neither a uniform policy nor are there uniform methods when referring to standards in legal provisions. In addition to this, governmental and private standards-writing organizations often exist side-by-side without any coordination.

The resulting confusion of technical rules has detrimental consequences for economic and technical development. This is particularly true in threshold and developing countries, where legislative measures and standards-writing intermingle. At the same time, many threshold and developing countries have very high expectations of standardization being able to raise their industrial level of development so as to enable them to fulfil the quality requirements imposed on them by the world market. Despite the diversity of other conditions in the individual countries, there is still a common interest in coordinating, harmonizing and raising the level of national standardization. The decisive prerequisite for this is a clear definition of the distribution of roles between standardization and legislation.

There are a number of conceivable forms in which standards can achieve a significant status in practice, either as a de facto binding force or by references contained in legal provisions. These range from an all-encompassing declaration of their binding effect, on the one hand, to a completely voluntary application, on the other. The following is intended to illustrate this using Germany as an example. A further section will examine the issue of how standards in Germany are established and monitored.

Finally and very briefly, special mention will be made of the problems of threshold and developing countries in this respect, and the question of whether it is possible to transfer the German and EC approaches to such countries. In order to comprehend the position of standards in the legal system of Germany, it is first necessary to clarify the legal quality of the standards. On the basis of this, it is then possible to outline the consequences of the use of standards in the law.
To achieve a better understanding of the links between standardization and law in Germany, a brief account of the hierarchical structure of legal norms is given, i.e. the types of legal norms that exist and how they are arranged in relation to each other.

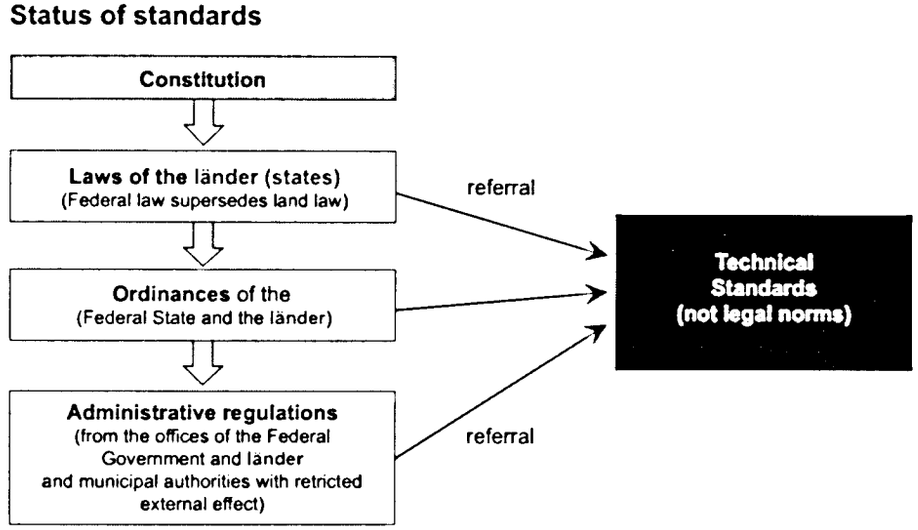


Figure: Status of standards (© pro-norm.de)

3 The hierarchy of legal norms

The uppermost position in the legal hierarchy of the Federal Republic of Germany is occupied by the Constitution, the Basic Law. The Constitution regulates, among other things, the legislative authority of the Federal Government and the individual Federal States. The Basic Law contains the fundamental principle 'Federal law supersedes Land law'. Federal laws therefore occupy a lower position than the Constitution of Germany but are superior to all state (land) laws and ordinances. Federal laws are passed by the Federal Parliament, the Bundestag and the Bundesrat in line with their legal competence, and state (land) laws by the respective parliaments of the Länder. Laws do not usually contain detailed rules but general requirements of conduct. Ordinances have a lower status than Federal Laws and are issued by the Federal Government or by the Federal Minister responsible, and at the state level by the parliaments of the Länder. Their scope is restricted to the extent of the powers of the law upon which they are based. Ordinances frequently regulate the details for enforcing the laws and, just like the laws themselves, have a generally binding force.

This ranking also applies to state law: constitution of the federal state, laws, ordinances. Below the ordinances come the administrative regulations, which can also largely be regarded as legal norms, albeit with limited binding character. Administrative regulations are binding instructions from public authorities to

subordinate offices, which serve to define the organization and operations of the administration more precisely. Although the ordinary citizen is not directly bound by these regulations, he does in practice experience their immediate effects. Statutory decisions frequently do not actually materialize until the level of administrative regulations.
In addition, statutory regulations are charters passed by legal entities in public law on the basis of autonomous statutes and articles. An example is provided by the regulations governing the prevention of occupational accidents in the German professional insurance associations: these regulations are binding upon the members and all those insured by the association. In contrast, technical standards are not legal regulations and do not therefore have a direct legally binding effect, unless this be through reference included in legal norms or contracts under private law. But even in these cases, technical standards do not regularly lose their voluntary character, and merely become binding in terms of their content. Thus, there is no group of standards in Germany that may be said to be binding in every case. Consequently, it is also impossible to indicate the percentage of compulsory and voluntary standards, as is the case in some countries.

4 The de facto binding force of technical standards

Legal obligation does still not imply that a technical standard will actually be observed in practice. The greater the extent to which a technical standard is applied in practice, the more likely it will be that a "de facto binding force" exists. As one example, a de facto binding effect may result from the incorporation of technical standards into market 'laws', or alternatively from laws in which sanctions are imposed for the infringement of technical standards. De facto binding force is to be found at its most extreme amongst the safety standards, which are integrated right through the legal system, by references contained in laws, ordinances and administrative regulations. Manufacturers and users adhere to such standards in order to avoid detrimental legal consequences, be they indirect coercive measures, such as a ban on technical systems, which contravene the rules, or direct measures, such as product liability. However, even standards concerning rationalization and quality, which are generally not referred to in the law, often achieve a de facto binding force in a market economy founded on intense competition. Economic disadvantages sustained on the market, from products not meeting a certain standard, do effectively result in manufacturers being forced to adhere to the requirements. These may lead to it becoming impossible to sell particular products if they do not comply with the relevant technical standards. Paper manufacturers producing non-standardized paper formats, for instance, would not stand a chance on the market in Germany or the European Union as the relevant EN DIN

standards have completely established themselves. This, in turn, affects the manufacturers of products that are dependent upon the paper formats, such as office equipment. These manufacturers must then also bring their products into line with these standards

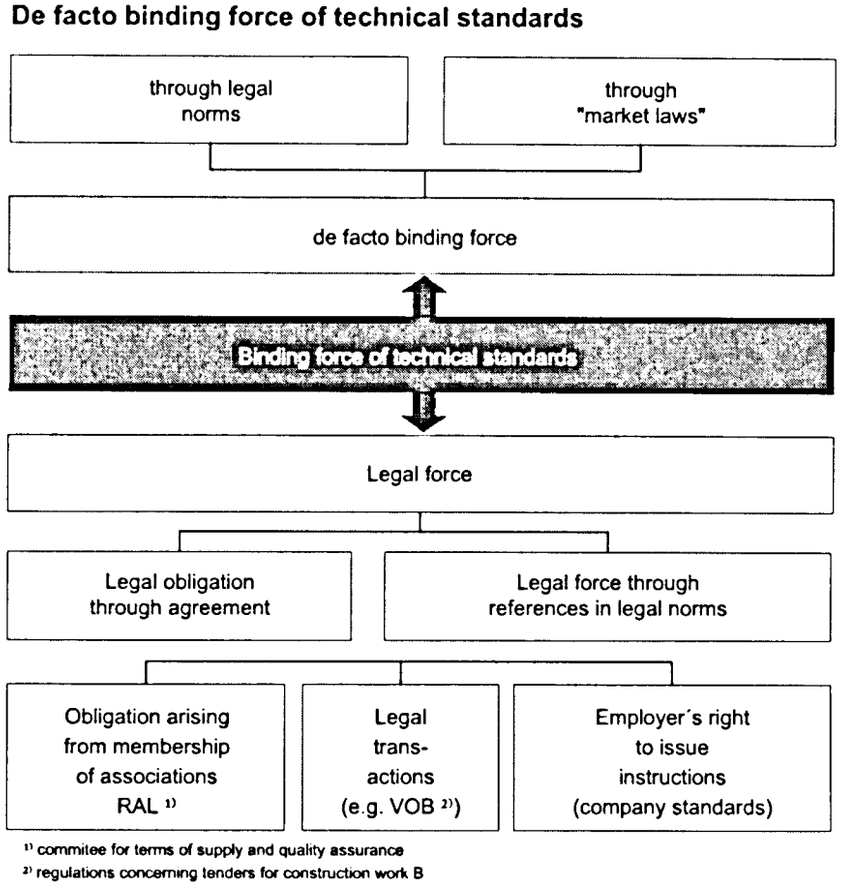


Figure: De facto binding force of technical standards (© pro-norm.de)

Further examples of a strong de facto binding force are the so-called 'basic standards', i.e. standards with a wide range of applications and general, fundamental significance. These include standards for thread sizes and other small components, such as screws, nuts, rivets and the like, which are produced in large quantities and are constantly required in industry and the trades. In terms of their binding effect, such standards of measurement and quality match the

safety standards. Without actually being so, they resemble the legal norms in economic practice. Thus, there is a de facto coercion to comply with a technical standard, and the intensity of this coercion depends on the nature of the standard.

De facto effect due to market forces

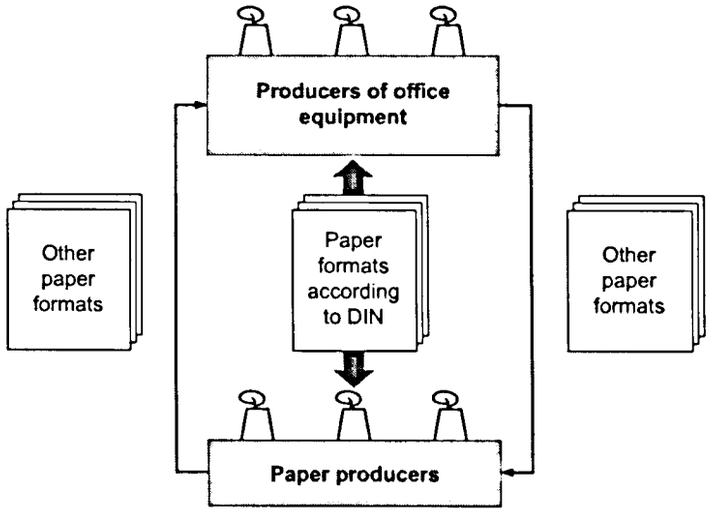


Figure: De facto effect due to market forces (© pro-norm.de)

5 Legal status on the basis of agreement

Apart from references in legal regulations, technical standards may acquire legally binding status by their inclusion into agreements made under private law. An example is provided by the RAL associations for marks of quality ('RAL' stands for Ausschuss für Lieferbedingungen und Gütesicherung, which translates as the committee for terms of supply and quality assurance), which are organized as registered associations under private law. Anyone wanting to use a mark of quality must join one of these associations or make a special binding declaration to adhere to the association's charter. Under the rules of the associations, the members are duty-bound to observe the conditions of quality and testing as well as the special terms relating to the award and use of the mark of quality. In cases of infringement, the association can impose sanctions, which may extend to permanent withdrawal of the quality mark. It is precisely the threat of these sanctions that proves such an effective measure in enforcing

adherence to the quality requirements. Because the mark of quality is so effective in terms of its advertising impact, withdrawal of the permission to use it generally brings noticeable losses of income in its wake.
Besides the marks of quality in Germany, there are also the so-called 'test marks'. The most well-known of these include the VDE, the GS and the DIN marks of testing and surveillance.

Legal status on the basis of agreement



For electrical wiring material, such as sockets, plugs, fuses, cable and wiring as well as components, such as capacitors, inductors, light fittings and consumer electronics.

Figure : Legal status on the basis of agreement (© pro-norm.de)

Legal status on the basis of agreement



For technical appliances such as tools, machines.

Figure: Legal status on the basis of agreement (© pro-norm.de)

While quality marks certify quite generally that the quality of a product has been tested and supervised, test marks tend to refer to the adequacy of the product in terms of technical safety requirements. Thus, they certify that it can be used without any exposure to danger. Anyone wanting to use this test mark does not have to join the corresponding organization, but enters into a special contract with the DIN or VDE, in which the rights and obligations are regulated. As a rule, one of the conditions for awarding the mark is that the product should comply with the relevant technical standards. The user of the mark also makes a commitment to continually monitor his own production and

is subjected to an inspection by the association's own test station. Violation of the conditions permitting the use of a test mark may be punished with a caution, a contractual penalty or withdrawal of the authority to use the mark. As in the case of the mark of quality, withdrawal of the test mark is an effective lever in ensuring compliance with the underlying technical standards. Due to its significance in terms of technical safety and the fact that it is extremely well known, the test mark is also an effective tool for advertising. Furthermore, supervisory authorities frequently waive the special government inspection if a test mark certifies adequate levels of technical safety.
A manufacturer will therefore have to bargain with substantial commercial disadvantages if he is no longer permitted to use the test mark. Hence, in the field of safety, the test mark is an important instrument for enforcing technical standards. The organizations responsible for setting the standards, DIN and VDE, thus occupy a position of considerable economic power, which is occasionally the subject of criticism from the law.
The target of such criticism is the situation arising from private institutions setting up guidelines for compliance with technical standards. Although these guidelines only apply de jure to the association members and contractually bound manufacturers, their de facto binding force does in fact extend to everybody. However, the problem of constitutional legitimacy posed by associations with such far-reaching powers will not be expanded upon any further at this stage.
Technical standards most frequently achieve legally binding status in trade and industry by contractual reference being made to them. They then become an element of the contract and legally binding on the parties to the contract. In this way, for instance, the quality of a product according to the terms of the sales contract, tenancy agreement or contract for work is laid down by means of DIN EN or other standards, which leads to simplification and rationalization of the processes involved in placing and accepting the order.
An example of this is provided by contracts for construction work where agreement is predominantly based on the application of the so-called "Vergabe- und Vertragsordnung für Bauleistungen" (VOB), a set of regulations concerning tenders for construction work. The VOB contains some 60 DIN and EN standards covering all fields of construction and civil engineering. Some of these standards contain cross-references to further standards which then also become incorporated into the contractual relationship.
Finally, the legal status of technical standards within a company arises from the authority the employer has over the employee due to the contract of employment. This authority also extends to compliance with what are known as 'company standards'. Company standards thus become legally binding by virtue of reference to them under labour law.

Construction contact procedure

The VOB Vergabe- und Vertragsordnung für Bauleistung (Construction contract procedures) were created by the Deutschen Vergabe- und Vertragsausschuss für Bauleistungen (DVA) (German Committee for construction contract procedures). The DVA is an association in which the public authorities and leading organizations within the construction business have jointly been involvd in the development of the VOB/B with the aim of creating rules for the management of construction contracts that lead to a fair compromise between the interests of the building owner and the building contractor.

Public bodies awarding contracts are obliged to agree the validitiy of the VOB/B in contracts with their contractors. However, without being under any compulsion, the parties to a contract often also agree that the VOB/B should apply in construction contracts awarded by private bodies.

Figure: Construction contact procedure (VOB) (© pro-norm.de)

6 Legal status through references contained in regulations

We have established that technical standards in the Federal Republic of Germany have no generally binding power. As the subject matter of contractual agreements and the employer's right to issue instructions, they may, however, attain a relative legal status which is restricted to the relationship in law of the two parties concerned or the individual company, respectively. Technical standards obtain a more extensive legal significance by statutory regulations that contain references to them. References to technical standards may be found above all in the law concerning safety technology. The State is constitutionally bound to minimize hazards originating from technical equipment and plant, by appropriate statutory regulations, so as to protect the life and health of its citizens. For several reasons, the legislative method of reference to standards has proven to be very effective in this respect.
Reference to standards relieves the legislator of his burden as he then does not have to carry out the preparation of the individual technical standards himself. His lack of relevant expertise would in any case render him unqualified for this task. At the same time, the legal text is kept free of complicated and often very extensive detailed provisions. It also serves to make statutory regulations clearer and more comprehensible if they only stipulate basic requirements. Furthermore, reference to standards makes the content of the law more flexible in terms of adaptation to the latest level of technical progress, if reference is made to the version of a technical standard in force at the time (so-called dynamic references). Amendment of the law with its attendant costly legislative procedure will then not be required every time a standard is changed. Finally, legal reference to non-governmental technical standards guarantees the participation of expert groups in setting the laws. It thus contributes to the

existing laws and technical standards included gaining a higher level of acceptance and recognition.

Legal status through references contained in regulations

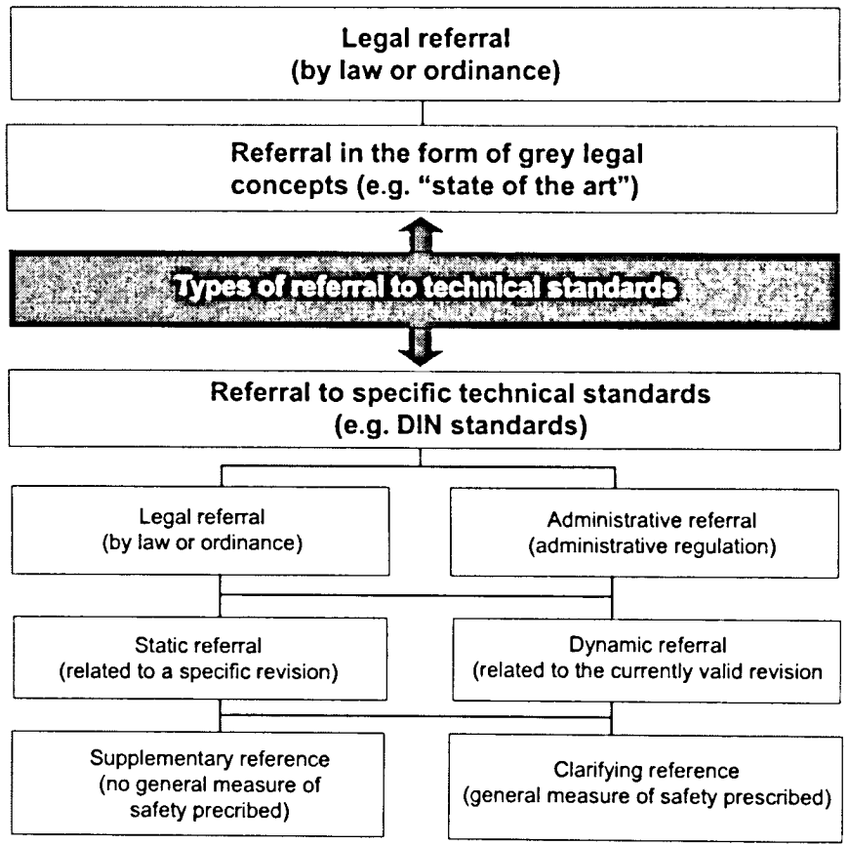


Figure: Legal status through references contained in regulations (© pro-norm.de)

There is a differentiation between references to specific technical standards, according to whether they are 'static' or 'dynamic'. We speak of a 'static' reference if it refers to one specific version of an individual or several technical standards, by explicitly defining them according to page number, title and date of issue. Dynamic references to technical standards are only permissible under German Law if the technical standards are not legally binding. It would otherwise be possible for the private standards-writers to change the law with each amendment to a technical standard, which is not compatible with the constitutional principle of democracy. In comparison, references granting merely privileges when fulfilling certain technical standards are permissible, as it is in the case of Section 4, Subsection 2, Sentence 4 GPSG. Above all, the advantage of dynamic over static references is that they allow for a more flexible reaction when technical standards have to be adapted to the latest state of the art.

In Germany, statutory reference to technical standards has a tradition in the law governing safety systems which stretches back over several decades. However, numerous other foreign legal systems also use this legislative method, which overall is of major significance as an instrument for unifying technical safety law. It has already been a part of the EC's legislative procedure for some considerable time. In addition to this, there are also recommendations from ISO, IEC, the Economic Council for Europe (ECE), the UN and the EC Commission that, where possible, laws should refer to national, multinational or international standards, and that the principle of referring to standards should be encouraged.

6.1 Reference to technical standards in the field of product safety

In Germany technical law is primarily laid down in the Equipment and Product Safety Act (Geräte- und Produktsicherheitsgesetz, GPSG), the law governing the safety of technical work equipment and consumer products.

The GPSG is intended to ensure that only products that are free of defects related to technical safety should come onto the market. It is also intended to offer a legal tool for combating technical hazards at 'source', i.e. during the design and manufacture of the products. In the GPSG the legal concept of 'product' covers two categories: 'technical work equipment' and 'consumer products'. Technical work equipment means products used exclusively for work purposes. The term 'consumer products' is introduced for products that are meant for consumers or that could be used by them. Moreover, consumer products does not just mean new goods, under certain conditions also used products are covered.

The fundamental obligations to safety which such products have to meet when bringing them into circulation are laid down in Section 4 und 5 GPSG.

Section 4 sets up the main safety guidelines and references to ordinances and technical standards which define the necessary details. The resulting obligations to safety affect manufacturers, importers and dealers who bring the product into circulation. Section 4 GPSG knows two types of references to technical standards. Section 4, Subsection 1 contains a reference to certain ordinances which comprise indefinite (or grey) legal concepts and internal references to technical standards to put the general legal concepts in concrete terms. Section 4, Subsection 2 can be regarded as blanket clause for all products

not being covered by a certain ordinance under Subsection 1. Sentence 1 of Subsection 2 determines the general terms for bringing a product into circulation through using the indefinite (or grey) legal concepts 'endangering', 'safety' and 'health'. Sentences 3 and 4 as reference terms bring technical standards into play by declaring that they could be used to assess whether a product meets the requirements set down in Sentence 1.
Section 5 lays down additional conditions for consumer products only, regarding certain obligations of information, warning, examination, withdrawal and marketing which the manufacturer, his representative and the person who brings the consumer product on the market have to meet.
Bringing into circulation and display pursuant to Section 4,
(1) Where a product falls under a statutory ordinance according to Section 3, Subsection 1, it may only be brought into circulation if it satisfies the requirements specified there regarding safety and health and other conditions for its being brought into circulation, and if the safety and health of the users or third parties or other legal assets mentioned in the statutory ordinances according to Section 3, Subsection 1 are not endangered through intended use or predictable incorrect use. If a standard which implements a harmonized Standard satisfies one or more requirements regarding safety and health, it shall be assumed for a product manufactured in accordance with this standard that it meets the relevant requirements regarding safety and health.

Section 4, Subsection 2 points out the following,
(2) Where a product is not subject to Section 4, Subsection 1 it may only be brought into circulation if it is such that, with intended use or predictable incorrect use, the safety and health of users or third parties are not endangered. When assessing whether a product meets the requirement of Sentence 1 the following must be considered in particular:
1 the characteristics of the product, including its composition, packing, assembly instructions, installation, maintenance and duration of use,
2 its effects on other products, where it is to be expected that it will be used together with other products,
3 its appearance, presentation in the trade, marking, warning signs, instructions for use and operation and indications for its disposal as well as all other product-related indications or information,
4 the groups of users exposed to a greater risk when using the product than others. When a product is assessed as to whether it satisfies the requirements according to Sentence 1, standards and other technical specifications may be referred to as a basis. If a standard or other technical specification which has been determined by the Committee for Technical Work Equipment and Consumer Products and published by the delegated body in the Bundesanzeiger (Federal Gazette) satisfies one or more requirements regarding safety and health, it shall be assumed for a product manufactured according to this standard or other specification that it satisfies the relevant requirements regarding safety and health.

In Section 4, Subsection 3:
(3) In the case of an item of technical work equipment covered by statutory ordinances according to Section 3, Subsection 1, the legal situation at the time it is first brought into circulation in the European Economic Area shall govern. Sentence 1 also applies for a consumer product where it is covered by statutory ordinances according to Section 3, Subsection 1. In the case of an item of technical work equipment not covered by a statutory ordinance according to Section 3, Subsection 1, the legal situation at the time it is first brought into circulation within the scope of the present Act shall govern. When a consumer pro-duct is brought into circulation which does not fall under a statutory ordinance according to Section 3, Subsection 1, the legal situation at the time it is brought into circulation shall govern.
Ordinances under Section 4, Subsection 1 GPSG are governed as follows in Germany:
(1) The Federal Ministry of Economics and Labour may, in consultation with the Federal Ministry of Consumer Protection, Food and Agriculture, the Federal Ministry of the Environment, Nature Conservation and Reactor Safety, the Federal Ministry of Defence and the Federal Ministry of Transport, Construction and Housing, adopt ordinances under the provisions of Sentence 2 for products after a hearing by the Committee for Technical Work Equipment and Consumer Products with the consent of the Bundesrat (upper house of parliament) in order to fulfil obligations arising from intergovernmental agreements or to implement or perform the statutory regulations passed by the European Communities.
A statutory ordinance under Sentence 1 can govern the following:
1. health, requirements for the protection of other legal assets and other conditions for display, bringing into circulation or commissioning, especially tests, product surveillance or certification,
2. requirements concerning marking, retention and notification obligations and hence related actions by authorities.

(2) The Federal Ministry of Economics and Labour may, in consultation with the Federal Ministry of Consumer Protection, Food and Agriculture, the Federal Ministry of the Environment, Nature Conservation and Reactor Safety, the Federal Ministry of Defence and the Federal Ministry of Transport, Construction and Housing, adopt ordinances under the provisions of Sentence 2 for products after a hearing by the Committee for Technical Work Equipment and Consumer Products with the consent of the Bundesrat (upper house of parliament), adopt statutory ordinances for products which do not fall under a statutory ordinance under Subsection 1 in order to regulate bringing into circulation or display of such products under the provisions of Sentence 2. Statutory ordinance under Sentence 1 can govern the following:
1 requirements relating to the guarantee of safety and health and other conditions for display or bringing into circulation, especially tests, product surveillance or certification,

2 requirements concerning marking, retention and notification obligations.

(3) The Federal Ministry of Economics and Labour may, after a hearing by the Committee for Technical Work Equipment and Consumer Products and with the consent of the Bundesrat, also specify in greater detail by statutory ordinance requirements for approved bodies with respect to the following in order to implement or perform the statutory regulations passed by the European Communities:
1 the independence, technical competence and Professional reliability of the body,
2 the availability of the required personnel, the necessary means and equipment,
3 the existence of an appropriate third-party liability Insurance policy,
4 the protection of Company and business secrets,
5 the placement of subcontracts,
6 participation in groups for the exchange of experience,
7 Quality Management
(4) By statutory ordinance without the consent of the Bundesrat, tasks which have been assigned to the delegated body within the framework of the present Act may be assigned to another federal authority which has been entrusted with tasks in the field of equipment and product safety. The statutory ordinance shall be adopted by the Federal Ministry to whose operational domain the federal authority belongs in consultation with the Federal Ministry of Economics and Labour.
(5) Statutory ordinances under Subsection 1 or 2 may be adopted without the consent of the Bundesrat in urgent cases or if this is necessary to ensure the immediate implementation or performance of statutory acts of the European Communities; such ordinances shall cease to be effective at the latest six months after they have come into effect. Their validity can only be extended with the consent of the Bundesrat.

6.2 Legal status of technical standards

The kind of legal reference used in the GPSG and the corresponding ordinances following the New Approach does not affect the status of technical standards in the same way as other possible legal references. The technical standards concerned retain their private character and remain legally non-binding.

7 Enforcement and control of technical standards

One important area where standardization makes a decisive contribution to enforcement and control is that of certification. Certification is understood to mean that a neutral and independent body confirms the conformity of products to certain standards. The practical significance of certification is particularly great in the areas of trade where standardization plays a crucial role (e.g. electrical engineering, electronics and mechanical engineering).

There are sectors in which minimum requirements are specified by EU directives. The manufacturer of such products is obliged to carry out a conformity assessment procedure and affix the CE Mark to the product. Together with the declaration of conformity, this is a signal from the manufacturer that the product complies with the directives. If the product from company A is to be tested by an independent body, this is referred to as Third-Party Certification. It is important to point out that the CE Mark is not a mark of quality!

The decisive factor in determining the practical worth of a technical standard is whether there is an effective legal mechanism for its enforcement and control. In Germany, particularly in the field of safety engineering, there is a highly complex legal system of control and enforcement mechanisms based on public, private and criminal law. Alongside these, as already mentioned, there are informal market pressures to keep in line. The GPSG is taken once again to serve as an example. The GS mark (Geprüfte Sicherheit = tested for safety) certifies that a product conforms with the requirements of the Equipment and Product Safety Act (GPSG), which are de facto specified in the accident regulations of professional insurance associations, DIN and EN standards or other technical standards in the sense of Section 4 GPSG. Certification is intended to protect the user and third party against injury when the equipment is put to its intended purpose but also when misused in a foreseeable manner.

The GS inspection examines whether the product complies with the requirements of the GPSG. If the product falls within European directives (e.g. low-voltage directive or machinery directive), the requirements of these directives are also tested. This also entails an appraisal of whether the operating instructions are comprehensible and complete. Functional tests are only included in the scope of the testing where they are essential for inspecting safety.

The GS mark is therefore not a general quality mark. Quality over the lifespan of a product is not inspected. To be allowed to affix the GS mark and receive a product-related certificate, the manufacturer must have his product subjected to a type examination by an approved test station (GS body, e.g. LGA, TÜV, BG-PRÜFZERT). A list of all GS bodies is available from the Federal Institute for Occupational Safety and Health (Bundesanstalt für Arbeitsschutz und Ar-beitsmedizin). The GS mark means that a test station authorized by the

German state has inspected the product and that any changes to the product are notifiable.

The GS mark is a legally regulated test mark for product safety in Germany the use of which is voluntary according to Section 7 GPSG.
All other marks, such as ENEC, VDE, ÖVE, TÜV, DIN-approved, etc. are private marks from individual testing or certification bodies or agreements between testing companies. The GS mark can be awarded for technical work equipment and for ready-to-use consumer products (e.g. machinery, hand tools, toys, electrical equipment, lighting devices, household appliances or furniture).
Unlike the CE mark, certification in accordance with the GS mark is voluntary. The CE mark is intended to regulate the free traffic of goods in Europe and is affixed by the manufacturers, who are themselves responsible. Consequently, the CE mark is neither a quality mark nor a product safety mark.

7.1 What are the consequences of violating the GPSG?

Inspections are carried out by the competent authorities at the premises of importers and dealers and in companies that use the technical work equipment. If, during this inspection, a product is found not to meet the safety requirements of the GPSG, the authority first of all

- tries to reach an agreement with the importer or manufacturer on the measures necessary to eliminate the defect.
- If an agreement cannot be reached, the party concerned may be forbidden, by means of a prohibition order, from placing further quantities of the product concerned on the German market.
- Contraventions of this order are subject to fines or penalties pursuant to Section 19 GPSG.

Violations of the GPSG may, however, also have consequences under private law. If an official ban on sale of a product does come into effect, the customer of the importer or manufacturer can stop further supplies of products of this type by withdrawing from the contract. Products which have already been delivered are subject to claims resulting from the contract of sale, which for example entitle the customer to return any such products. Claims for rectification also come into consideration. If, due to its defectiveness, the product causes personal injury or damage to property, then the manufacturer responsible may be faced with claims for damages according to the principles of manufacturer's liability.

Other contributions to enforcing the GPSG are made by the accredited test stations which, on request, examine whether a particular product or item of technical work equipment should be permitted to carry a test mark, with its

inherent advertising impact. In other words, the test stations examine whether the product complies with the GPSG. In the case of machinery in terms of Annex IV of the Machinery Directive, there is a duty to contact a notified body.
One important area where standardization makes a decisive contribution to enforcement and control is that of so-called certification procedures. Certification is understood to mean that a neutral and independent body confirms that products conform to standards. The interest in certification systems is constantly increasing at national (non-European nations), regional (e.g. EU, MERCOSUR, NAFTA, etc.) and also international level. In threshold and developing countries certification is one of the main instruments for the implementation of standards. The practical significance of certification is particularly great in the areas of trade where standardization plays a large role, e.g. electrical en-gineering, electronics and mechanical engineering. Manufacturer A wants to inform customer B that his product meets the standards taken as the basis for the delivery terms. He can do this by way of a document, known as the declaration of conformity, completed in his own hand affirming that: 'The product ABC has been tested and manufactured in accordance with the standard XYZ'.

Structural models of certification 1

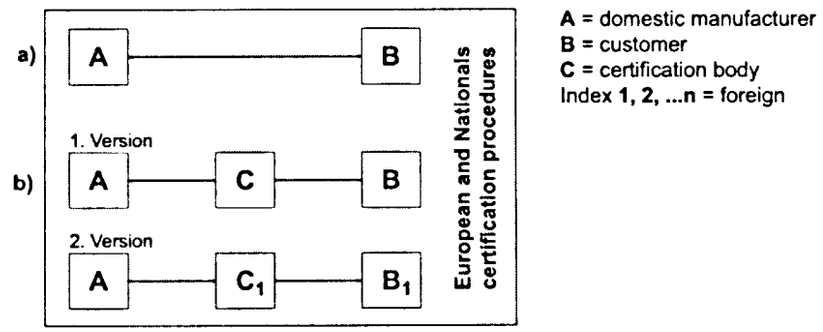


Figure: Structural models of certification 1 (© pro-norm.de)

Structural models of certification 2

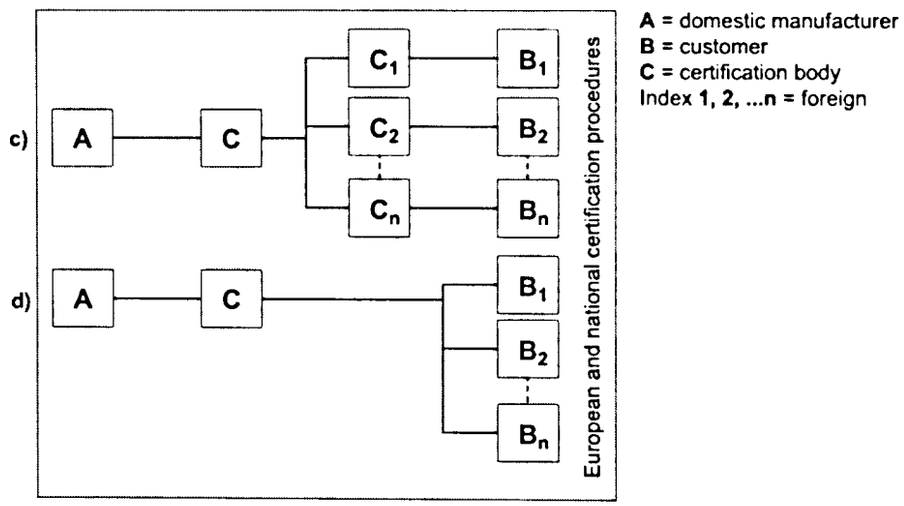


Figure: Structural models of certification 2 (© pro-norm.de)

Where of such a direct relationship between manufacturer A and customer B (Case a), reference is made to a manufacturer's declaration. On the other hand, if manufacturer A's product is tested and certified by an independent body, then this is called third-party certification (Case b, first version). Thus, a third position enters into the relationship between manufacturer and customer, in the form of the certification body. Case b, second version represents the case where a foreign (in the sense of outside of Europe) customer, B_1, is supplied, and the test mark of the corresponding foreign certification body, C_1, is affixed to the product.

Case c illustrates the situation where manufacturer A not only wants to supply his tested product to the home market, but also to countries 2 and 3, with the appropriate test marks for those countries (in the sense of countries outside of Europe). Repetition of the test procedure with the foreign certification bodies C_2 and C_3 is, however, both inconvenient and time-consuming. For this reason, regional and international certification are becoming more and more popular.

In European and international standards bodies (e.g. CEN and ISO), harmonized standards and test procedures are developed, and agreement is reached that test results are approved according to a standard recognized by all the participating certification bodies. The national test result then only needs to be presented to the appropriate foreign (outside Europe) certification body in order to acquire its test mark for customers B_1 and B_2 (Case C). The procedure is made easier still if a test mark that has been awarded nationally or within Europe

is sufficient, and the manufacturer has direct proof for his customers B^1 and B^2, without referring to a further certification body. Case d illustrates this situation where all the participating certification bodies recognize products bearing a harmonized mark as if it were their own mark of conformity. Cases a and b illustrate two methods of certification according to the national and European procedures, in Case. c and Case d the method according to regional and international procedures is shown.

A national and a supranational (European) certification systems serve both the economy and the consumers. They may be organized under private law, as is the case for example in the Federal Republic of Germany, or prescribed by law, as in the Scandinavian countries. Most of the certification bodies in threshold and developing countries are under state control. Although certification in the Federal Republic of Germany is voluntary, it is backed up by statutory regulations, such as the administrative regulation for the GPSG. The relevant technical standards of the DIN, the VDE and the DVGW as well as the regulations governing the prevention of accidents at work form the basis for obtaining the GS test mark according to the Equipment and Product Safety Act. The procedural stages that a national or foreign (non-European) applicant has to pass through at the VDE test station arise from the articles of the VDE, which as a registered association is organized under private law.

German test stations which are permitted to carry out certifications and inspections within the framework of the GPSG are nominated by the ZLS (Zentralstelle der Länder für Sicherheitstechnik). The detailed procedure of nomination is laid down in an ordinance according to Section 3, Subsection 3 GPSG. For example, a certified body is accordingly only admitted if its staff and expertise are adequate for this function, and it is able to guarantee reliable testing. The requirements placed on testing and certification stations are also specified for example in the EN 45000 standards series up to the year 2000, and thereafter ISO 17025. If operating in the European harmonized area, the certified body must be notified to the Commission of the European Communities, with this notification only being valid for one particular directive.

The nomination of a test station (certified body) does not mean that its activity obtains sovereign character. However, without government or European recognition no testing station may perform its work within the legally regulated area, e.g. award a GS mark. For many threshold and developing countries the accreditation of private laboratories under government supervision would also be one way of taking some of the load off standards bodies, which are often charged with this task. However, such moves are frequently frustrated because the government is afraid of losing too much influence. Yet, a stronger degree of decentralization is unavoidable in creating a more effective certification structure, which - as mentioned previously - has a crucial significance for the implementation of standards. Increased effort should therefore be put into bringing about changes in this aspect of the law in threshold and developing countries.

7.2 Market surveillance

According to Section 8 of the GPSG, the competent authorities have to guarantee effective surveillance of the bringing into circulation of products as well as the products brought into circulation on the basis of a monitoring approach. The monitoring approach shall encompass in particular the following:

- the logging and evaluation of information available in order to determine major deficiencies and goods flows;
- the establishment, regular adjustment and implementation of monitoring programmes with which the products are monitored on a spot-check basis and with the scope of testing required, and the logging and evaluation of such programmes and
- the regular checking and evaluation of the efficacy of the approach.

In the case of products subject to a statutory ordinance according to Section 3, Subsection 1 and bearing a CE mark, the competent authority assumes that the requirements laid down there in each case are satisfied. In the case of technical work equipment and ready-to-use commodities bearing the GS mark according to Section 7, Subsection 1, it shall be assumed that they satisfy the requirements with respect to safety and health under Section 4, Subsections 1 and 2 and other statutory regulations.

(3) The supreme State ('Land') competent authorities shall ensure co-ordination of the monitoring of the bringing into circulation of products and of products brought into circulation, the development and updating of the monitoring approach and the preparation of cross-State measures to ward off major hazards.

(4) The competent authority shall take the necessary measures if it has reason to suspect that a product does not satisfy the requirements under Section 4. It is authorized in particular:

- to prohibit the display of a product if the conditions of Section 4, Subsection 5 are not met,
- to order measures to be taken which ensure that a product is only brought into circulation if it satisfies the requirements under Section 4, Subsections 1 and 2,
- to order that a product be inspected by an approved body or a similarly qualified body,
- to order that suitable, clear and easily comprehensible warning signs indicating hazards associated with the product are affixed. Such warning signs shall be in German,
- to prohibit temporarily the bringing into circulation of a product for the period required absolutely for testing purposes,
- to prevent a product which does not satisfy the requirements of Section 4, Subsections 1 and 2 from being brought into circulation,
- to order that a product brought into circulation which does not satisfy the requirements of Section 4 is taken back or recalled, to secure such a product and, if it is not possible to eliminate a danger for the user or a third party in any other way, to arrange for its safe disposal,
- to order that all those who may be exposed to a danger associated with a product brought into circulation are informed in good time in a suitable form of such a danger, especially by the manufacturer.

The authority itself may warn the general public if other, similarly effective measures, and specifically warnings by the manufacturer, are not taken, or not in good time. It shall waive measures under Sentence 2 where suitable measures are taken to ensure that the danger associated with a product is warded off by the person responsible for bringing the product into circulation.

(5) The competent authority shall address measures under Subsection 4 pri-marily to the manufacturer, his authorized representative or the importer. It may also address measures to the dealer according to the relevant needs. Measures taken against any other person shall only be permissible provided that a major and present danger cannot be warded off in any other way. If the other person suffers damage from this, he shall be compensated for this provided he has no way of obtaining compensation elsewhere or his assets are not protected by the measure taken.

(6) If a product bearing a mark according to Section 7, Subsection 1 Sentence 1 does not satisfy the requirements under Section 4, Subsection 1 or Subsection 2, the competent authority shall notify the GS body which has awarded that mark and the authority according to Section 11, Subsection 2.

(7) The competent authorities and their delegated representatives are empowered to enter premises or sites in or on which products are manufactured, stored for the purpose of bringing them into circulation or displayed, to inspect the products, to test them or to have them tested, and in particular to have them put into operation for this purpose. The persons who manufacture the product or who store or display it for the purpose of bringing it into circulation can be called upon to bear the cost of the tests under Sentence 1 if the test shows that the requirements under Section 4 are not satisfied.

(8) The competent authorities and their delegated representatives may take samples and demand specimens free of charge.

(9) The manufacturer, his authorized representative, the importer and the dealer shall in each case accept measures under Subsection 7, Sentence 1 and Subsection 8 and shall support the competent authorities. They are obliged to provide the competent authority on demand with the information required to enable it to perform its tasks.

The person thus obliged may refuse to provide information to questions if answering such questions may expose him or a related person designated in Section 383, Subsection 1 Nos. 1 to 3 of the Code of Civil Proceedings to the risk of criminal prosecution or proceedings under the Act Governing Infringements of Administrative Regulations. He shall be informed of his right to refuse information.

(10) The competent authorities and the delegated body shall inform and support one another on measures taken under the present Act. If the authorities receive information falling under the heading of business secrecy they shall safeguard its confidentiality.

7.3 Penal provisions and fines

§ 19 Penalties and administrative fines
(1) A person is committing an administrative offence if he/she wilfully or negligently infringes a statutory ordinance or an enforceable order based on such a statutory ordinance where the statutory ordinance refers to this regulation on administrative fines for a certain state of affairs,
(2) The administrative offence may be penalized by a fine of up to thirty thousand euros, and in the other cases by a fine of up to three thousand euro.

§ 20 Regulations governing criminal penalties
A person who persistently commits a wilful action described in Section 19, Subsection 1, No. 1 Letter a, No. 5 or 6, Letter a or who through such wilful action endangers the life or health of another or alien property of significant value will be punished by imprisonment for up to one year or by a fine.

Aims of the EC policy

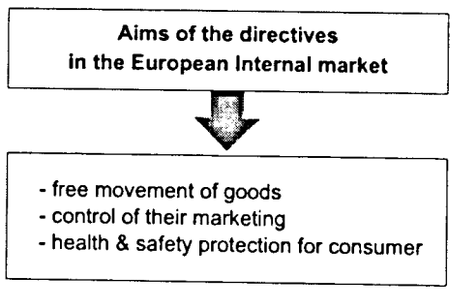


Figure: Aims of the EC policy (© pro-norm.de)

8 EC policy in the field of technical law and technical standards

The most important aim of the EC policy in the field of technical law and technical standards is to remove technical trade barriers arising from the Member States' differing requirements for technical products and their use.

In what is known as the NEW APPROACH, the Commission of the European Union (EU) formulates the following principles relating to the integration strategies: In certain areas it is absolutely essential to create uniform law. In the remaining areas it must be possible for the mutual recognition of technical standards to suffice as a means of guaranteeing the free transport of goods.

The contents of the necessary legislation must be limited to the essential requirements for health and safety. Individual national regulations thus become superfluous if the necessary minimum requirements are defined in Community law. This means that it is also possible to dispense with regulations for individual products. The directives based on the 'New Approach' are completed by European standards. Specific definitions are avoided in the directives. European standards that specify the means of complying with the essential requirements are drawn up and published by (CEN/CENELEC/ETSI). The Member States accept that if a product meets the European standards, then the essential requirements of the directives are fulfilled.

8.1 3-pillar principle

The declared objectives of removing barriers to trade are achieved by the creation of a three-pillar principle:
- mutual recognition,
- notification and
- legal harmonization.

Mutual recognition:
The principle of mutual recognition obligates the EC Member States beyond the corpus of harmonized law to accept products and product standards of other Member States in line with Article 28 EEC Treaty. It imposes considerable limitations on national sovereignty because Member States are largely expected to relinquish their own laws.

Notification
The notification directive imposes a duty to notify on all Member States in connection with matters of technical legislation. Drafts for technical regulations have to be communicated to the EC Commission, which then passes them on to the

remaining Member States. Both the Commission and the remaining states can attach comments that have to be given consideration when draw- ing up the national technical regulations. If the Commission is planning its own directive with identical content, this has priority over the national regulation. If necessary, the European standards bodies (CEN/CENELEC/ETSI) can be requested to prepare European standards within a specified time period. This not only prevents the generation of new technical barriers to trade but is also a way of achieving legal approximation and the harmonization of technical standards.

Legal Harmonization

The essence of the legal harmonization in the field of technical law and technical standards is to be seen in the EC directives policy following the "New Approach". The New-Approach Directives are based on Article 95 EEC-Treaty. They contain the main safety guidelines for certain products as well as references to non-legally binding harmonized technical standards. If a product meets the requirements of the corresponding harmonized technical standard it is regularly assumed that it complies with the EC directive and can be brought the European market. These standards have to be adopted by the national standards organizations within a period of six months. Older national standards with the same contents then have to be rescinded.

This leads to the creation of a single harmonized body of rules for the whole of Europe. Nevertheless, the use of standards remains voluntary. Market access remains open for non-standardized products if the requirements of the directives are fulfilled. Only in this way is it possible to ensure an opportunity for innovation.

National implementation of EC directives

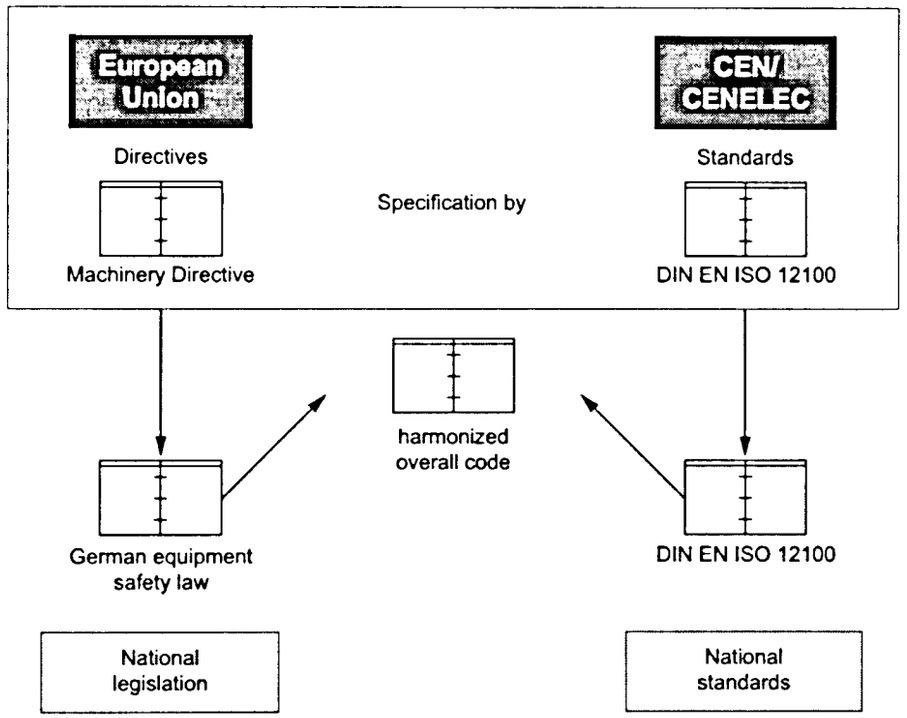


Figure: National implementation of EC directives (© pro-norm.de)

9 Notes on standardization in threshold and developing countries

In Germany the legal and de facto binding force of technical standards derives from references contained in laws, agreements made under private law, or from competition. In most threshold and developing countries these preconditions for making technical standards binding are missing. It is therefore difficult to enforce standards. Often there is insufficient acceptance in the economy for both the written law and the whole concept of standards. This is compounded by a lack of legal means for monitoring and enforcing standards. One approach for increasing the use of standards might lie in the creation of an efficient certification system.

Consumer behaviour is an important factor in enforcing standards and hence in the creation of quality products. High-quality products cost several times more than those of an inferior quality. Companies will continue to produce low- quality products as long as they can sell them. Consequently, there is no

incentive to improve quality. Introducing standards with a mandatory character to specify quality does not lead to success, nor is this procedure socially acceptable. Forcing cheap products from the market would make a great number of products inaccessible for large sections of the population, who simply would not be able to afford these goods any more. Ultimately, this means that standards cannot be satisfactorily established without first overcoming the problem of poverty. Accommodating different quality levels in standards is not a policy that can be supported. The task of national standards institutes is to prescribe a defined quality level as a guiding objective for industry and commerce through standards.

As has been seen, the legal status of technical standards in Germany results directly from references in legal norms and from agreements made under private law. Most threshold and developing countries lack the appropriate preconditions to enable them to use this method of making technical standards legally binding and thus securing greater legal validity. There are too few statutory regulations covering the field of technology, and contractual agreements do not materialize because the completely different market structure (suppliers' market) means that they only appear to make sense in export trade. In addition to this, there is no means of enforcement due to the absence of regulations concerning liability law, and the competitive situation does not permit a de facto binding effect.

The standards structure in threshold and in developing countries is generally a part of government economic policy. In such countries, technical standards often have the status of statutory provisions so that they take effect more quickly. Decreeing by law that standards are generally binding does not automatically lead to their being used by everyone, owing to the lack of appropriate enforcement measures. Added to this is the fact that standards with direct binding force are not flexible enough and may obstruct innovation.

However, mandatory standards are useful when they are able to fill gaps left by an absence of protective laws, e.g. in the areas of consumer and environmental protection and industrial safety. Thus, in some threshold and developing countries where there has previously been no safety legislation, attempts are being made to repair the balance by the introduction of mandatory safety standards. Before deciding on the fields of technology that could benefit from mandatory standards with powers of sanction, it is necessary to give careful consideration to the social needs, options and consequences. In general, enforcing standards presents great difficulties. There is often insufficient acceptance in society for both the written law and the whole concept of standards. In addition to this, there is a lack of legal means for the surveillance and enforcement of standards. The result is that official instructions to conform with the standards are not observed and there is considerable hesitation when imposing the sanctions threatened.

One approach to increasing the application of standards might be for the threshold and developing countries to first of all create an efficient system of certification with appropriate surveillance. Standardization and certification

can be grouped together in one organization, or at least under a common roof, so that experience gained from testing can be put to immediate use in the drafting of standards. Apart from a central certification office, there is also a need to create a network of decentralized testing laboratories, which should cover as extensive an area as possible. A precise examination is required to determine whether a mandatory or a voluntary standard is most suitable for a particular sector. The findings should be assessed, documented and, where appropriate, used to bring about a change in the legal status of the standard concerned.

The task of standards bodies in threshold and developing countries is to collect such examples of the benefits of standardization and make them public so as to reinforce the awareness of standardization. One major prerequisite to establishing standardization is an appreciation of the return on investment. Everybody concerned, industry and consumers alike, must feel that quality improvements are rewarding.

In contrast to export trade, this attitude has not yet been transferred to the domestic markets of most threshold and developing countries. Consumer behaviour is obviously one important factor here. Good quality products cost several times as much as inferior products but last many times longer. The level of poverty amongst the people leaves them no other choice than to buy inferior quality goods because these are all that they can finance. However, as long as inferior products remain marketable, companies will continue to lack the ne-cessary incentive to improve quality and use standards.

This situation might give rise to the opinion that as many mandatory quality standards as possible should be introduced, so as to force standards into use. However, this type of solution is neither promising in terms of success, nor is it socially acceptable. On the one hand there is no technical or legal apparatus to detect and, where appropriate, sanction violations of conformity with the standard. Mandatory standards would largely exist only on paper. On the other hand, forcing cheap products out of the market, with the aid of stringent mandatory standards, would not be acceptable in view of the great diversity of buying power amongst the population. It would mean depriving large sections of the population of a great number of consumer goods, because they would no longer be able to afford them.

Different levels of quality for national products must therefore continue in existence for as long as the population's overall buying power remains at a low level. Ultimately, it will not be possible to implement standards in a satisfactory manner until the problem of poverty has been solved. Different levels of quality must not, however, be adopted into the standards themselves. National standards, particularly in the absence of standardization within industry and the economy (company standardization), must set a certain quality level as a target if they are to fulfil their function of providing industry with guiding assistance. For this purpose standards need not necessarily be given a mandatory character. On the whole, mandatory standards should remain the exception. This is especially true of indispensable safety requirements for the

protection of life, limb and property of the consumer, and for avoiding the serious financial after-effects for the state, which follow in their wake. Confidence in market forces is not justifiable in these cases.
A desirable state of affairs would be if industry were to reach a conviction that standardization enables safety requirements to be met while at the same time keeping production costs low. But even where safety standards are concerned, a close examination should always be carried out to see whether the entire standard needs to be mandatory, or whether it is perhaps sufficient to legally prescribe only a part of it. Mandatory standards may pose a special problem for small-scale industry so that it becomes necessary to weigh up the requirements of safety and cost-effectiveness.
This can be illustrated by a further example from Thailand. It concerns the standard for gas cylinders, which are generally used for cooking. They were being produced incorrectly by a few companies, and this was leading to hundreds of dangerous accidents per year. A mandatory standard was therefore introduced which also specified the size and weight of contents the cylinders were to have. In contrast to this, in other countries a gas cylinder may have any size within a certain spectrum. To industry, this standard represented an obstacle to exports. An additional rule was therefore introduced, according to which a company can apply for a permit to manufacture non-standardized sizes for export or other legitimate requirements.

The example shows that a mandatory standard which has a thoroughly positive effect for the domestic market - in this case easier comparability and greater safety - can still have negative effects, especially for exports. Great care should therefore be taken, particularly in the drafting of a standard, that all requirements have been taken into account. When defects do arise, there should be sufficient flexibility to correct them quickly.

10 The status of standardization in threshold and developing countries

Standardization as it exists in Germany has grown over time and now forms a complex system. This system cannot simply be transferred to threshold and developing countries. An individual and cautious approach is required when introducing standards systems in threshold and developing countries. A law for creating a standards system can have a supporting effect and thus provide a legal framework to be filled by all those involved. Lack of willingness on the part of industry and commerce to cooperate in the preparation of standards is a major problem, which can be best managed through efforts of persuasion and public relations work. Only a knowledge of the economic benefits of standardization will promote a partnership with industry and commerce.

The system of standardization that has evolved over time in Germany now forms a complex structure that is not always readily comprehensible. Its roots are predominantly in the private business sector (e.g. DIN, TÜV, and VDE test stations) but also partially in the public domain (e.g. Physikalisch-Technische Bundesanstalt (PTB), Bundesanstalt für Material¬prüfung (BAM) and weights and measures inspectorates). This system cannot easily be transferred to countries in the process of industrialization. A more realistic view would be to use the experience of industrialized countries in a selective and directed manner, by conducting detailed analyses of the particular country's requirements and special conditions.

Principles of DIN's standardization work

- voluntary
- public
- relevant
- carried out with all interested groups
- directed towards the common good

Figure: Principles of DIN's standardisation work (© pro-norm.de)

On the whole, the facilities that have emerged in threshold and developing countries are purely government-controlled. Apart from standardization, metrology and testing, they also perform the functions of quality control, certification, documentation and sometimes even issue the relevant legislation. Due to the technical economic and socio-political conditions in these countries, standardization is practically only feasible at the governmental level. Most threshold and developing countries are confronted with the problem that national industry does not itself display the necessary engagement for the preparation of standards. Selecting a purely private-law solution for a standardization institution is therefore regarded as very difficult, as experience in eastern European countries since 1990 has shown.
A decisive factor in a state-run standardization system is that the relevant organizations be issued with a clear, statutory mandate for issuing and implementing standards, which provides the code established with a legally binding character. This type of standards law must define the nature and scope of governmental influence on standardization and the extent to which the institutions are able to work independently. In addition to this, regulation should include the participation of consumers, science and the remainder of the business sector. Furthermore, statutory regulation must specify the standardization procedure.

It is also important to provide financial security for the standardization institutions and clear rules of responsibility when standardization is distributed amongst different organizations. Standards concerning a particular field, e.g. environmental standards, should as far as possible remain the responsibility of one organization. Requirements made of the form and content of the standards themselves should also be controlled in terms of such aspects as clarity, freedom from contradictions of other standards, definition of scope and instructions for use.
Insufficient information on the use and terminology frequently makes it difficult for standards to gain acceptance. If the scope of a standard's validity is not clearly defined, it may lead to overlap in the case of an amendment. Overlap between different standards should also be excluded. Test methods forming the basis for product inspection also require regulatory measures so as to guarantee the uniformity of the inspection system, and identify which generally accepted method is to be followed. Periodic revision of the standards should be prescribed by law too. A standardization law may also be of assistance to threshold and developing countries. However, it can only provide the legal framework for the details which have to be filled in by the participants. The lack of willingness to cooperate in the drafting of standards on the part of industry and commerce within developing countries is, for example, a problem that can only be overcome by persuasive effort and public relations work.

11 Summary

A worldwide comparison of the countries where standardization is practised shows that the respective role played by standards and legal requirements varies considerably. Even within one country, there is neither a uniform policy nor are there uniform methods when referring to standards in legal provisions.
There are a number of conceivable forms in which standards can achieve a binding status, either as a de facto binding force or by references contained in legal provisions. These range from an all-encompassing declaration of the binding effect of standards, on the one hand, to a completely voluntary application, on the other. This has been illustrated for the territory of Germany. A further section examined the issue of how standards in Germany are established and monitored.
The uppermost position in the legal hierarchy of the Federal Republic of Germany is occupied by the Constitution, the Basic Law. The Constitution regulates, among other things, the legislative authority of the Federal Government and the individual Federal States. Federal laws therefore occupy a lower position than the Constitution but are superior to all state (land) laws and ordinances. Federal laws are passed by the Federal Parliament, the Bundestag (the lower chamber) and the Bundesrat (the upper chamber) in line with their

legal competence, and state laws by the respective parliaments of the länder. Below the ordinances, which have a lower status than the federal laws, come the administrative regulations, which can also largely be regarded as legal norms. In addition, statutory regulations are also charters passed by legal entities in public law as autonomous statutes and articles. An example is provided by the regulations governing the prevention of occupational accidents in the German professional insurance associations; these regulations are binding upon the members and all those insured by the association.
In contrast, technical standards are not legal regulations and do not therefore have a direct legally binding effect, unless this be through reference included in legal norms or agreements under private law, e.g. associations for marks of quality such as DIN, VDE; GS, RAL, in other words by way of a contract.
In technical law, reference is made to grey legal concepts by means of the so-called blanket clause method. This reference only encompasses the general requirements relating to technical safety, which are only more closely defined in ordinances and administrative provisions.
There is a further differentiation between references to specific technical standards, according to whether they are static or dynamic. We speak of a static reference if it refers to one specific version of one or more technical standards, by explicitly defining them according to number and title of the standard and the date of issue. Dynamic references to technical standards are only permissible under German Law if the technical standards are not legally binding. Technical standards obtain a more extensive legal significance by statutory regulations that contain references to them. References to technical standards may be found above all in the law concerning safety technology. The State is constitutionally bound to minimize hazards originating from technical equipment and plant, by appropriate statutory regulations, so as to protect the life and health of its citizens. For several reasons, the legislative method of reference to standards has proven to be very effective in this respect.

In Germany, statutory reference to technical standards has a tradition in the law governing safety systems which stretches back over several decades. This is demonstrated by means of the GPSG. Due to the Law for realignment of the safety of technical work equipment and consumer products, which was published on 9 January 2004 (Federal Law Gazette I 2004, 2), the Equipment and Product Safety Act (Geräte- und Produktsicherheitsgesetz, GPSG) superseded the Product Safety Law (ProdSG) and Equipment Safety Law (GSG) in Germany on 1 May 2004. This marked the implementation of European Directive 2001/95/EC (General product safety) into national law in Germany. According to Section 1, Subsection 1, the Act governs 'the bringing into circulation and display of products as implemented independently within the framework of an economic enterprise' and also, according to Section 1, Subsection 2, 'the erection and operation of installations subject to mandatory inspection which serve commercial or economic purposes or which may endanger employees', irrespective of the exceptions mentioned in further paragraphs of these

clauses. The GS mark can be awarded for technical work equipment and for ready-to-use consumer products (e.g. machinery, hand tools, toys, electrical equipment, lighting devices, household appliances or furniture).
The GS mark is the only legally regulated test mark for product safety in Europe. All other marks, such as ENEC, VDE, ÖVE, TÜV, DIN-approved, etc. are private marks from individual testing or certification bodies or agreements between testing companies.
Unlike the CE mark, certification in accordance with the GS mark is voluntary. The CE mark is intended to regulate the free traffic of goods in Europe and is affixed by the manufacturers, who are themselves responsible. Consequently, the CE mark is neither a quality mark nor a product safety mark. Finally and very briefly, special mention will be made of the problems of threshold and developing countries in this respect, and the question of whether it is possible to transfer the and EC approaches to such countries.

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13 Glossary

Administrative regulations
Rank below ordinances and can also be regarded as legal norms, albeit with limited binding character. They are binding instructions from public authorities to subordinate offices, which serve to define the organization and operations of the administration more precisely.

Administrative provision
Appropriate provision is necessary within law and both judicial and administrative practice if these most important areas are to contribute positively to the supportive and enabling nature of that environment. Legal provision may take various forms appropriate to the national legal system, it should address the status, rights and responsibilities of cooperatives and the cooperative movement in general, as well as, if appropriate, those of special categories of cooperatives or of distinct aspects of cooperation.

Basic standard
Standard that provides a structured description of (aspects of) interrelated entities to facilitate human communication about these entities, and/or to be used in other standards. Examples of basic standards include:
- terminology standards
- standards providing quantities and units (e.g. SI: Système Internationale d'unités: the International System of Units)
- standards providing classifications and/or codes, (e.g., currency codes) standards providing systematic data (e.g. ergonomic standards describing man's characteristics and abilities, such as dimensions of the human body; these data are used in other standards)

- standards providing reference models (e.g. the OSI (Open Systems Interconnection) reference model: a 7-layer model developed to solve the problem of the interconnection of computer systems).

Blanket clause method
technical law, reference is made to grey legal concepts by means of the so-called blanket clause method

Basic requirement
There are sectors in which minimum requirements are specified by EU directives. The manufacturer of such products is obliged to carry out a conformity assessment procedure and affix the CE Mark to the product. Together with the declaration of conformity, this is a signal from the manufacturer that the product complies with the directives.

Blanket clause method
In technical law, reference is made to grey legal concepts by means of the so-called blanket clause method. This reference only encompasses the general requirements relating to technical safety, which are only more closely defined in ordinances and administrative provisions.

CE Mark
Certifies the conformity of a product with the essential requirements of the directives and confirms that the product has undergone all the relevant assessment procedures in line with Community legislation.

Certification
According to the European standard EN 45020 "certification of conformity" is used to mean inspection by an impartial third party to show that a correctly designated product, process or service complies with a specific standard. In the context of legal harmonization, the issuing of a certificate serves as proof that the product meets specific laws or other technical specifications and criteria, i.e. it complies with or conforms to these.

Company standard
A company standard is a measure to introduce uniformity that is only valid for one particular enterprise (cf. Kleinemeyer 1997, p. 53).

Conformity assessment procedure
(Also conformity testing) Systematic assessment of the extent to which a product, process or service fulfils the prescribed requirements.

Conformity
Conformity signals agreement with the applicable directives or with health and safety requirements from these directives as well as with the necessary legal provisions for drawing up the declaration of conformity and affixing the CE Mark.

Consumer product
Term for products that are not used exclusively for work

Declaration of conformity
The declaration of conformity is...
- a procedure in which the manufacturer or his authorized representative established in the Community declares that the machinery placed on the market complies with all the relevant safety requirements of the appropriated directive.
- a form that is to be supplied with every machine and must be drawn up in the user's language.

Self Declaration of Conformity (SDoC) A declaration of a (first) party which has assessed itself its own product, service, management system or other entities and declares that it meets certain requirements.

De facto binding effect
The de facto binding effect may result from the incorporation of technical standards into market 'laws', or alternatively from laws in which sanctions are imposed for the infringement of technical standards.

Developing country
The population's overall buying power is at a low level in these countries. Due to the technical economic and socio-political conditions in these countries, standardization is practically only feasible at the government level. Most threshold and developing countries are confronted with the problem that national industry does not itself display the necessary engagement for the preparation of standards.

Dynamic reference
Dynamic references to technical standards are only permissible under German Law if the technical standards are not legally binding. It would otherwise be possible for the private standards-writers to change the law with each amendment to a technical standard, which is not compatible with the constitutional principle of democracy.

Equipment and Product Safety Act
(Geräte- und Produktsicherheitsgesetz, GPSG) is the law governing the safety of technical work equipment and consumer products. The Equipment and Product Safety Act (GPSG) is intended to ensure that only products that are

free of defects related to technical safety should come onto the market. It is intended to offer a legal tool for combating technical hazards at "source", i.e. during the design and manufacture of the products. In the GPSG the definition product is introduced as a general term and is divided into the categories of "technical work equipment" and "consumer products".

Essential requirements
Requirements that represent the core of European Union law around which an effective policy has been developed in matters of safety, health and other measures for those areas covered by the 'New Approach directives'. (www.cenorm.be/BOSS/glossary.asp)

European Directive
Prepared by the European Parliament, the Council and the Commission, "a directive shall be binding, as to the result to be achieved, upon each Member State to which it is addressed, but shall leave to the national authorities the choice of form and methods." (Article 249 (ex Article 189) of the EC Treaty)

European Community
The European Community was established by the Treaty establishing the European Economic Community on 25 March 1957 in Rome. It was aimed at the "harmonious development of economic activities", a "continuous and balanced expansion" and "increased stability". To this end a common (or single) market was to be created. The EC constitutes the most important pillar of the EU.

European standard
Standard adopted by CEN/CENELEC and carrying with it an obligation of implementation as an identical national standard and withdrawal of conflicting national standards (CEN/BOSS Glossary: http://www.cenorm.be/BOSS/glossary.asp)

Federal Gazette
The official German "Federal Law Gazette" (BGBI- Bundesgesetzblatt) and the Federal Gazette publish federal laws and statutory instruments of the federal government as well as memoranda from government authorities or legal and private notices required by law. They are published by the German Ministry of Justice and issued by the Federal Gazette Publishing Company.

Federal Constitutional Court
The Federal Constitutional Court (Bundesverfassungsgericht, or BVerfG) is Germany's Supreme Court, and its role is essentially "Guardian of the Constitution".

GPSG
(Geräte- und Produktsicherheitsgesetz) = Equipment and Product Safety Act

Grey legal concept
Statutory reference in the form of grey legal concepts encompasses all the more general requirements relating to technical safety, which are only more closely defined in ordinances and administrative regulations. The grey legal concept "generally acknowledged rules of technology" designates the general measure of safety that manufactures, importers and dealers have to observe.

GS inspection
examines whether the product complies with the requirements of the GPSG. Functional tests are only included in the scope of the testing where they are essential for inspecting safety. The GS mark is therefore not a general quality mark. Quality over the lifespan of a product is not inspected

GS mark
the GS mark (Geprüfte Sicherheit = tested for safety) certifies that a product conforms with the requirements of the Equipment and Product Safety Act (GPSG), which are specified in the accident regulations of professional insurance associations, DIN and EN standards or other generally recognized rules of technology.

Harmonized standard
Technical specification adopted by European Standards Organizations, developed under a mandate given by the European Commission and/or European Free Trade Association, in support of essential requirements of New- Approach Directives. NOTE: This concept is different from the concept of 'Harmonized standard' used by ISO/IEC and by the ‚Low Voltage Directive' (CEN/BOSS Glossary: http://www.cenorm.be/BOSS/glossary.asp#N)
Harmonized standards are those which have been drawn up by CEN or CENELEC on the instructions of the EU and on the basis of directives, and which are to be implemented nationally. They guarantee the interchangeability of products, processes and services or the mutual comprehensibility of test results or information which is presented in accordance with these standards.

Hazard
The ability to cause damage.

Hazard analysis
The hazard analysis specifies which hazards can be generated by machinery and how they can be eliminated by design measures.

International law
Set of rules usually drafted and issued under the auspices of an international organization such as the United Nations which specifies the rights and obligations of legal entities acting on an international level under a given legislative domain.

Law
Set of rules issued by an authorized legislative body specifying rights and obligations of those legal entities coming under a given legislative domain.

Legal harmonization
The essence of the legal harmonization in the field of technical law and technical standards is to be seen in the EC directives policy following the "New Approach". The New-Approach Directives are based on Article 95 EEC Treaty. They contain the main safety guidelines for certain products as well as references to non-legally binding harmonized technical standards. If a product meets the requirements of the corresponding harmonized technical standard, it is regularly assumed that it complies with the EC directory and can be brought onto the European market. These standards have to be adopted by the national standards organizations within a period of six months. Older national standards with the same contents then have to be rescinded.

Legal norms
Legal norms can also largely be regarded as administrative regulations.

Legal requirement
Prerequisite as specified by an authorized legislative body for a given activity to be legitimate/lawful.

Mandatory standard
Technical specification that a given activity has to be compliant with to be legitimate/lawful.

Minimize hazards
The State is constitutionally bound to minimize hazards originating from technical equipment and plant, by appropriate statutory regulations, so as to protect the life and health of its citizens.

Mutual recognition
The principle of mutual recognition obligates the EC Member States beyond the corpus of harmonized law to accept products and product standards of other Member States in line with Article 28 EEC Treaty. It imposes considerable limitations on national sovereignty because Member States are largely expected to relinquish their own laws.

New Approach (07 May 1985)
EC directives only specify the essential health and safety requirements; European standards define the requirements at a high level of protection; affected groups are to be involved in drawing up standards; provision is to be made for safeguard clause procedures.

New-Approach Directive
Directives that have been put into force since May 1985 by the Council of the European Communities which define 'legislative harmonization in those sectors where barriers to trade are created by justified divergent national regulations concerning the health and safety of citizens and consumer and environmental protection, will be confined to laying down the 'essential requirements", conformity with which will entitle a product to free movement within the Community.' (CEN/BOSS Glossary: http://www.cenorm.be/BOSS/glossary.asp)

Notification
The notification directive imposes a duty to notify on all Member States in connection with matters of technical legislation. Drafts for technical regulations have to be communicated to the EC Commission, which then passes them on to the remaining Member States. Both the Commission and the remaining states can attach comments that have to be given consideration when drawing up the national technical regulations. If the Commission is planning its own directive with identical content, this has priority over the national regulation. If necessary, the European standards bodies (CEN/CENELEC/ETSI) can be requested to prepare European standards within a specified time period.

Notified body
Also called independent third body or impartial third body. Notified body means "a body that has been made known or announced". They are published in the Official Journal of the European Community. For the purposes of EC directives this is an organization that issues the EC type-examination certificates for compliance with the health and safety requirements contained within the relevant standard.

Ordinance
Ordinances have a lower status than Federal Laws and are issued by the Federal Government or by the Federal Minister responsible, and at the state level by the parliaments of the länder. They regulate the details for enforcing the laws and have a generally binding force.

Product liability
Product Liability is the responsibility that arises when the product which is in defective condition causes damage. The term product includes not only tangible goods but also intangible goods, such as electricity when it has reached the consumer.

Static reference
There is a further differentiation between references to specific technical standards, according to whether they are static or dynamic. We speak of a static reference if it refers to one specific version of one or more technical standards, by explicitly defining them according to number and title of the standard and the date of issue.

Third-Party certification
If the product from company A is to be tested by an independent body, this is referred to as Third-Party certification. It is important to point out that the CE Mark is not a mark of quality!

Quality mark
A quality mark certifies quite generally that the quality of a product has been tested and supervised. Anyone wanting to use a mark of quality must join an association for marks of quality or make a special binding declaration to adhere to the association's charter, in Germany. Under the rules of the associations, the members are duty-bound to observe the conditions of quality and testing as well as the special terms relating to the award and use of the mark of quality. It is effective in terms of its advertising impact and withdrawal of the permission to use it generally brings noticeable losses of income.

Statutory reference
This is a legislative method that is of major significance as an instrument for unifying technical safety law

Statutory regulations
Statutory regulations are charters passed by legal entities in public law on the basis of autonomous statues and articles.

Technical standards
Technical standards are not legal regulations and do not therefore have a direct legally binding effect, unless this be through reference included in legal norms or agreements under private law, e.g. by way of contract.

Technical work equipment
This term refers to products used exclusively for work purposes

Test mark
Besides the marks of quality in Germany, there are also the so-called "test marks". The most well-known of these include the VDE, the GS and the DIN marks of testing and surveillance. They tend to refer to the adequacy of the product in terms of technical safety requirements.

Threshold country
The population's overall buying power is at a low level in these countries. Due to the technical economic and socio-political conditions in these countries, standardization is practically only feasible at the government level. Most threshold and developing countries are confronted with the problem that national industry does not itself display the necessary engagement for the preparation of standards.

VDE test
The VDE is a registered association for marks of testing and surveillance (VDE marks or "test marks"), which is organized under private law.

Voluntary standard
A technical specification that a user is free to comply with.

14 Key questions

- How do standards achieve an agreed legal status
- Which regulation contains rules for ordinances containing the safety requirements for specific products according to Section 4 Subsection 1 GPSG?
- What function does the Equipment and Product Safety Act, GPSG, have in Germany?
- What are the consequences of violating the GPSG?
- What significance does the GS mark have in Germany?

Wilfried Hesser · Rudy Sayoga Gautama

Abstract

This teaching unit is designed to give the student a proper understanding of the EU New Approach and its consequences for a company that aims to sell its product on the European market.
At the same time, it is important that an awareness of the CE mark is created, in particular with regard to directives and harmonised standards. This means that information about the legal basics (laws and standards) and the CE marking procedure (including searching for standards, analysing hazards, conformity assessment procedures) must be provided.
Knowing something about the legal framework is a help when trying to understand the CE marking procedure. In this regard, the terms New Approach and Old Approach will be explained before dealing with the CE mark. In doing so, the three most important EC directives are briefly explained.
These are the Machinery Directive, Electromagnetic Compatibility Directive and the Low Voltage Directive.
The fundamentals of the CE mark are outlined in Section 5, in which the most important aspects such as product definition, conformity assessment, hazard analysis and declaration of conformity are individually addressed.
The CE mark, together with the declaration of conformity is the machine's "technical passport". Without a CE mark the machine cannot be placed on the market in the EU. A CE-marked product must comply with all the relevant directives affecting it. This mark also requires that the prescribed procedure for the conformitiy assessment should also be observed.
It is also important to clearly state that the CE mark is not a quality mark.

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1 Preface

The free movement of goods between member states is a cornerstone of the European internal market. In an effort to achieve this goal, mechanisms have been established by the EC Institutions to prevent the erection of new barriers to trade and to deal with mutual recognition and technical harmonisation.
The New Approach improved the conformity assessment to the extent that the EC Institutions were put in the position of evaluating the consequences of the application of various conformity assessment mechanisms.
A modular approach, in which the conformity assessment is divided into a series of stages (modules), was introduced with Global Approach. These modules differ according to the development stage of the product (e.g. design, prototype, full production), the type of assessment conducted (e.g. document audit, qualification approval, quality assurance) and assessment of the individual carrying it out (manufacturer or independent body).
The Global Approach was updated and completed by Council Decision 90/683/EEC and Decision 93/465/EEC. These resolutions stipulate the general guidelines and detailed procedures for conformity assessment that are used in the guidelines for the New Approach. Accordingly, conformity assessment is based on

- the manufacturer's internal design and production control activities;
- type examination by an independent body combined with the manufacturer's internal production control activities;
- type or design testing by an independent body combined with approval for quality assurance systems for products or production by an independent body or testing of the products by an independent body;
- inspection of the design and production by an independent body or
- approval for comprehensive quality assurance systems from an independent body.

Decision 93/465/EEC not only stipulates the guidelines for the use of conformity assessment procedures in technical harmonisation directives but also standardises the rules for the affixing and use of the CE mark.
The member states must assume that products bearing the CE mark comply with all provisions in the applicable directives governing their affixing. They must therefore not prohibit, restrict or prevent the placing on the market or the entering into service of such products within their territory unless the provisions regarding the CE mark have been incorrectly applied. If a hazard is not covered by the applicable directives, however, the member states, in exceptional circumstances, can prohibit, restrict or prevent the free movement of CE-marked products pursuant to Articles 28 and 30 of the EC Treaty.

Presumption of conformity
With regard to the conformity of products with national standards, provided that it concerns the transposition of harmonised standards whose references have been published in the Official Journal of the European Communities, it is assumed that they comply with the relevant essential requirements. If the

manufacturer has not applied or only partially applied such a standard, he must supply proof of the measures that he has taken to comply with the essential requirements.

Main elements of the directives for the New Approach
The directives for the New Approach are based on the following principles:

- Harmonisation is limited to the essential requirements.
- Only products that comply with the essential requirements can be placed on the market or entered into service.
- If products meet harmonised standards whose references have been published in the Official Journal and which have been transposed into national standards, compliance with the relevant essential requirements is assumed.
- The application of harmonised standards or other technical specifications remains voluntary, and manufacturers are free to choose from any technical solution, provided compliance with the essential requirements is guaranteed.
- Manufacturers can choose between various conformity assessment procedures, which are provided for in the applicable directives.

Products that comply with all the provisions of the applicable directives in which this mark is provided for must bear the CE mark. In particular, the CE mark specifies that the products comply with the essential requirements of the applicable directives and are subject to one of the conformity assessment procedures provided for in the directives. In addition, the member states must take steps to protect the CE mark.

Placing on the market and entry into service
The member states must ensure through appropriate measures that only products, which, by virtue of proper installation and maintenance and, which when used as intended, do not pose a risk to the health and safety of individuals or to other public interests covered by the same directive, are placed on the market or entered into service. This obliges the member states to initiate a process of market surveillance. In accordance with the EC Treaty (Articles 95 and 30), the member states can also enact other regulations, especially when it concerns the protection of employees, consumers or the environment. These regulations cannot, however, demand that any changes be made to the product or to the conditions for its placing on the market.**Conformity assessment**
Before a product is placed on the market in the Community, and in order to be able to affix the CE mark on the product, the manufacturer must subject it to one of the conformity assessment procedures provided for in the applicable directive.

Notified bodies: Conformity assessment procedures
Conformity assessment by an independent body is carried out by notified bodies. These are selected by the member states from those bodies that comply with the requirements stipulated in the directive and are based in their territory.

The member states must transpose the provisions of the directives into national law and inform the Commission about the measures that have been taken.
The aim of this section is to introduce the fundamentals of the CE mark. The websites of the European Commission also provide additional information.

1.1 Standardisation activity in Europe

A number of efforts have been made to establish the EC. One of them involves eliminating trade barriers within the EC itself. Unfortunately, this cannot work effectively since the barriers are interlinked with the different technical "cultures" prevailing in the member states. This phenomenon was not realised when drafting the Treaty (Nicolas & Repussard 1994, p. 71 ff.). When the EC was set up initially, the technological development in all member states was considered more or less at the same level. It made the cross-border exchange of goods within the EU easy. But by the time every member state had issued its own laws, regulations and directives on standardisation as well as its own standard systems, it meant that the cross-border exchange of goods within the EU became more difficult.
Due to the absence of technical trade barriers in the EC Treaty, a subtle interpretation of this Treaty is required to achieve integration of the European internal market. The approach towards the matter is outlined in Article 94 (ex-100) of the EC Treaty. It demands the harmonisation of laws and regulations of the member states. The Article enables the Council of the European Union and the Commission to issue instructions in order to create harmony in the European internal market.
In addition to what is stated in the Article, the committees of the EC had to clearly describe matters concerning the technical trade barriers using a series of sophisticated instruments. In other words, they had to specify the position of European standards during the creation of a European internal market. The use of those instruments is regulated in Directive 83/189/EEC "Information Directive", the "New Approach", and a number of Articles in the Single European Act.

1.2 The Old Approach in European standardisation

An agreement dated 28 May 1969, based on Article 94 (ex-100) of the, EC Treaty stipulates a method of harmonising European standards known as the "Old Approach" (Pelkmans 1987, p. 253 ff.). "Old Approach" stands for full harmonisation of any general or detailed condition a product shall meet by legislative means. The main goal of this approach was to achieve a maximum degree of harmonisation among European standards. However, it had some obstacles; one

of them being that it took some time before many standards were adopted, and when they were ready to be applied, they were already out of date.
It has been proven that the Old Approach failed to promote a uniform European market with harmonised standards. The inadequacies of the "Old Approach" have been identified as follows (Pelkmans 1987, p. 253 ff.):

- It required time-consuming and laborious procedures.
- Excessive trend towards unification.
- The principle of unanimity.
- Costly and time-consuming as additional work and inconsistencies resulted from insufficient coordination in the harmonisation process.
- Slow drafting process for standards at European level, particularly when compared to the process at national level.
- Disregard for certification and inspection problems.
- Problems of implementation in the member states.
- Low level of political interest for European standardisation, particularly in the Council.

The Commission of the EU made a decision to restrict the autonomy of the national European standards bodies when passing standards in light of the fact that the Old Approach was not working well. This decision is included in the Information Directive "(Directive 83/189/EEC) of 26 April 1983. The issue of the Information Directive has several goals, as outlined below (Nicolas & Repussard 1994, p. 80):

- Increasing the degree of clarity in the areas of European directives and European standardisation.
- Improving coordination among the member states especially by obliging national standards bodies within the EC to regularly inform other member states and the European standards bodies as well as the EC Commission about planned and newly developed national standards. The EC Commission has the right to block national standardisation projects in Europe.
- Promoting technical harmonisation and dismantling trade barriers within European countries.

A national standards body could ask CEN for a standardisation project at European level if it presumes that a similar project, which might act as a technical barrier to trade, is being conducted by another standards body. Or it could ask permission to participate in such a project.

- Empowering the commission of European standards bodies, particularly in the preparation of standards for common goods or the promotion of integration in the European internal market.

The efforts made by the Council of the European Union using the Old Approach were terminated with the issuing of the "Council Resolution of 7 May 1985".

1.3 The New Approach

What is considered to be the New Approach is codified in the "Resolution in the field of technical harmonisation and standardisation", 85/C 136/01, of 4 June 1985. According to Nicolas & Repussards 1994, p. 215 ff., the content of the resolution stipulates that:

- European standardisation was to be used as a tool for integrating the European internal market.
- Research and development in Europe was to be stimulated by qualitative and quantitative improvements in the European standardisation system, particularly in the fields of computer and information technology.

Up until the early 1980s, there was no indication that European standards were able to fulfil the increasing demand for standards in Europe. The spread of European standards had to be accompanied by the current reference to them based on European directives, resolutions and laws. The main points of the New Approach related to the standardisation effort and may be summarised as follows (Nicolas & Repussard 1994, p. 95 ff. and Hesser et al. 1994, p. 14 ff.):

- A uniform law was enacted throughout the EC regarding "essential requirements" in the area of health and safety or other areas affecting the common good. Stipulation of these general requirements obviates the need for individual member states to issue their own regulations in matters of health and safety. Products that satisfy the Commission's general requirements may be put on sale in all EC member states.
- In areas where no harmonisation is necessary, mutual recognition of national regulations for individual products will avoid obstacles to the movement of goods.
- Technical specifications, i.e. the precise technical formulation of the basic requirements laid down by the Commission, are included in the European standards. The use of the standards drafted in this procedure remains voluntary.
- A product that is manufactured in compliance with European standards may be presumed to satisfy the fundamental requirements of safety and the common good according to directives enacted under Articles 94/95 (ex-100/100a) of the EC Treaty. This product may then - subject to any necessary conformity assessment procedure - be marketed within the EC. However, a manufacturer should provide evidence that basic requirements have been met even if the product is not adhering to the European standards.
- The CEN unanimity principle is replaced with a qualified majority rule to prevent any delaying tactics which were possible under the regime of the Old Approach.
- The member states declare their willingness to observe the basic safety requirements laid down by the EC Commission in drawing up European standards.
- According to the Information Directive of 28 March 1983, the member states undertake to submit the drafts of national standards to the EC Commission (here the "Council Directive of 28 March 1983 dealing with a procedure for the provision of information in the field of technical standards and regulations", 83/189/EEC, EC Official Journal L 109 of 26 April 1983). The EC Commission reserves its right to veto so as to prevent any trade barriers or inconsistencies within the European standardisation system.
- Essential requirements are to be employed in those situations where the existence of standards is an ex ante requirement for the creation of markets.

A number of implications for the EC member states are entailed in the New Approach. They are as follows:

- The mutual recognition of national regulations in non-critical areas involves a not insignificant surrender of legal sovereignty for the member states of the EU. The EC member states are no longer free to enact their own regulations in non-critical areas.
- The obligation to submit the drafts of national standards to the EC Commission ("Notification") restricts the scope for drawing up national standards within Europe.

There is proof that the New Approach covers only the most important requirements for standards at European level. The directives are applicable to entire product groups but are not product-specific as was the case under the Old Approach (Hildebrandt 1995, pp. 109-125).
Several directives were activated based on the "Resolution for a New Approach in the field of technical harmonisation and standardisation" in which the Commission defined the approach more precisely as "essential requirements" in different fields. The "Low Voltage Directive" (73/23/EEC of 19 February 1973) acted as a model for a series of directives that were enacted under the regime of the New Approach (Nicolas & Repussards 1994, p. 101 ff.). The directives include the safety of toys, explosives for civil use and even medical equipment.
According to Nicolas & Repussards 1994, p. 99, there are some advantages of the New Approach:

- Only the essential requirements are laid down in the directives. This relieves the European political institutions of time-consuming, detailed standardisation work. The technical formulation of standards and the essential requirements are delegated to the bodies that are best qualified for this task.
- "Standardisation competition" is retained.

The New Approach
Key points of Council resolution
(07.05.1985)

- EC directives stipulate only the essential health and safety requirements
- European standards define the requirements of the EC directives at a high protective level
- Affected groups are to participate in the drawing up of standards
- Provision to be made for protective clause procedure

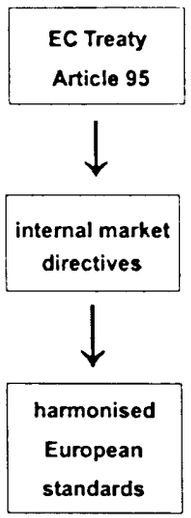


Figure: The New Approach (© pro-norm.de)

Three pillars of New Approach

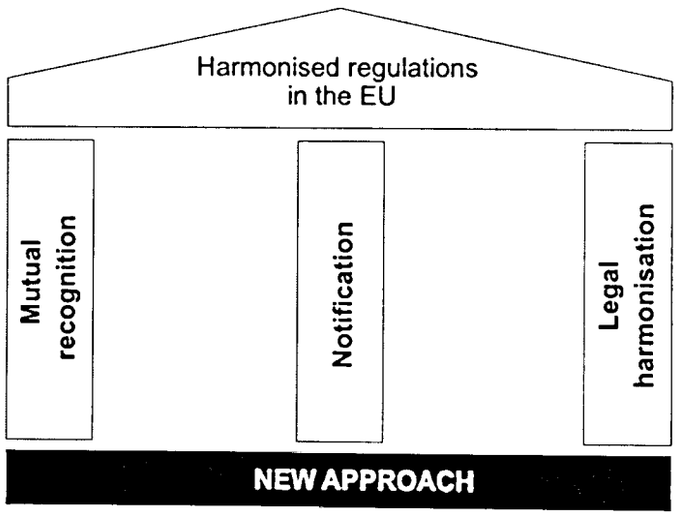


Figure: Three pillars of the New Approach (© pro-norm.de)

2 The EU directives policy and the concept of the single market

The creation of a European internal market becomes one of the important goals laid down in the European treaties. It specifically regulates the free traffic of goods, services and capital together with the unrestricted movement of labour. One of the ways to achieve this is to bring in a minimum harmonisation of the national laws within Europe and to create a uniform European system of standardisation. The main instruments in achieving this objective are the European directives, which are legally binding and must be transposed into national law.

Since the Treaty of Rome was signed in 1957, realisation of the basic cross-border economic freedoms as laid down by the EC Treaty (formerly EEC Treaty) has become the goal of the European Community and European Union. It was originally strived for under the term "internal market". The realisation of the basic freedoms covers the free distribution of goods and services, the free movement of labour and the free movement of capital, and is essentially dependent upon the creation of secondary Community law, i.e. the creation of directives and regulations. In 1985, the European Commission published the "White Paper for Completing the Internal Market" especially for the free distribution of goods (Langer 1995, p. 6).
It turned out that it was not possible to use the harmonisation of national laws as an instrument of legal approximation. The Commission made a decision that minimum harmonisation is not only sufficient but is also a better method for creating the internal market without borders (DIN 1994, Vol. 1, Chap. 1.2, p. 1).

In addition, the Community itself will in most cases instigate a restriction in order to specify the essential requirements for introducing products onto the market in future measures to approximate laws. "Directives exist in all sectors of the internal market. The directives based on Article 95 (ex-100a) and Article 137 (ex-118a) of the EC Treaty are of particular importance for the sale and use of industrial products as their function is to regulate the requirements for introducing products and improving the working environment." (Petrick 1997).

To fulfil the goal, the directives will include stipulations concerning
- the essential safety requirements for products,
- the conformity assessment procedures that the manufacturer must adhere to before he is allowed to introduce a product onto the market that falls within the scope of a directive,
- the power of testing laboratories and certification bodies which, as part of a specified conformity assessment procedure, determine whether a product fulfils the basic safety requirements. (Petrick 1997)

The EU directives cover not only EU-based manufacturers of technical goods who wish to sell the same model of product throughout the entire European internal market but also manufacturers from non-EU countries. As part of this condition, the creation of uniform requirements for all suppliers in the European internal market cannot be considered as a trade barrier for importers. Instead, the directives have provided access to the markets of all EU member states.

3 Areas regulated by directives and the Global Approach

The New Approach can only be applied in certain product groups in what are known as regulated or harmonised areas. A regulated area is the opposite of an unregulated area. If a certain product comes from a regulated area, a certain conformity testing procedure produces the conditions to allow it to enter the free circulation of goods (CE mark). Generally, the unregulated area is covered by the principle that the member states of the EU know each other's technical rules and standards and allow the relevant products to move freely within Europe. If a certain product does not meet the minimum health and environmental protection standards of an EU member state but at the same time has been proven to be needed, an exception is made in order to unify the European system of certification and accreditation and to avoid the various tests that a product might have to undergo at national level (Global Approach).

3.1 Areas regulated by directives

Regulated (harmonised) area
A distinction has to be made between the regulated (harmonised) area and the unregulated (non-harmonised) area (Ensthaler 1995, p. 18ff.).
The "regulated area" covers all products for which harmonisation directives as well as harmonised standards exist. The following are some requirements of the regulated area:

1 References for the relevant harmonised standards are published by the EU Commission in the Official Journal of the Union.
2 The standards must have been passed by European standards institutions as part of a standardisation order issued by the Commission which has been or is to be completed by harmonisation directives. These directives, provided they have been issued in accordance with the New Approach, correspond to the standardisation requests filed with the European standards institutions, which deal with the detailed problems during their standardisation work. In practice, compliance with directives is regularly achieved by means of compliance with standards.

The individual modules of the new conformity assessment procedure are available for individual products determined by the new harmonisation directives, which refer to the new (modular) procedure. The stipulation is based on the risk potential and also the nature of the products. For example, it may be determined that the CE conformity mark may be added to the product merely on the basis of a manufacturer's certificate (EC Declaration of Conformity) but it may also be determined that some kind of test or individual test must be conducted for the product. In addition, the company can also choose from a number of conformity assessment procedures. If this is linked to an inspection conducted by an independent third party, this kind of test only has to be carried out once within the Community. The inspection may take place in any member state. The manufacturer or importer can select from any of the EU testing bodies recognised by the member states and published in the Official Journal of the EU.

Regulated and non-regulated area

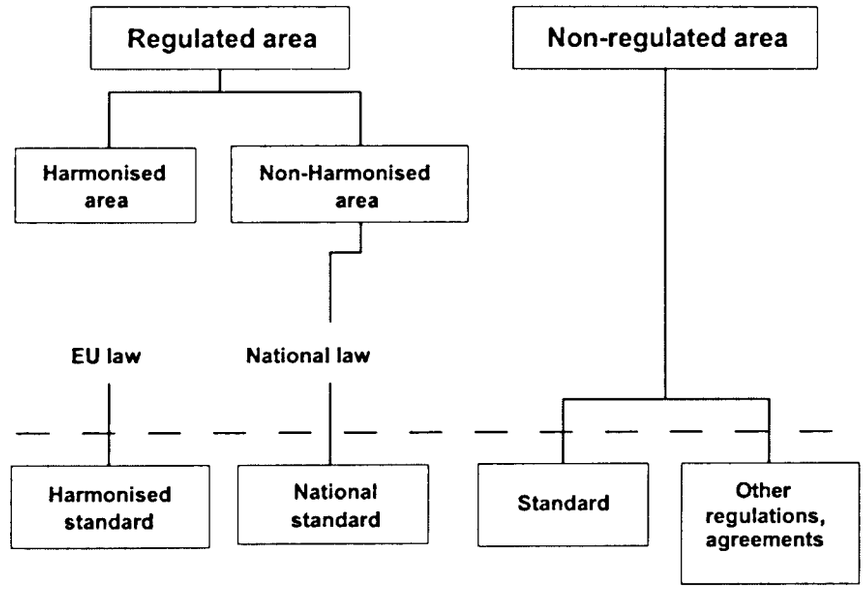


Figure: Regulated and non-regulated area (© pro-norm.de)

Unregulated (non-harmonised) area
When harmonisation directives do not exist for particular products, this is known as an "unregulated area". In such cases the member states are generally obliged to guarantee the free movement of goods, too (Article 28 EC Treaty). Although Article 30 EC Treaty provides exceptionally that a Member state may restrict the free movement of goods if this is justified on grounds of the protection of health, life, environment, etc. It is very helpful if this can be accompanied by national quality marks or standards systems in order to make sure that the products meet the requirements for technical safety on a national basis at least. In this regard, Grutzner 1994, p. 25, emphasises that because national conformity or quality marks are known or valid primarily within that particular country, and because customers often only have confidence in the conformity tests performed by recognised bodies, manufacturers regularly need tests, certificates and marks from the bodies within the country for which their products are destined.

3.2 Global Approach

Trade barriers may be caused by a refusal of the proof of conformity provided by other member states. The authorities usually ask for tests for imported products or even certificates issued in the destination country. To eliminate such trade barriers, a system is needed. It is a system in which the member states are always able to mutually recognise the manufacturers' declarations and the certificates issued by independent bodies. "The conformity assessment procedures in the directives issued prior to 1990 are not coordinated with one another and thus contain very divergent provisions." (Petrick 1997)
Based on the above, the Commission proposed what was then called the "Global Approach" which was aimed at achieving clarity in the system and a basis for comparing the test, certification and control bodies, so as to render the certificates more meaningful and the recognition concept functional. (Official Journal No. C 267 of 19 October 1989: "A Global Approach for certification and testing").

The Global Approach consists of
1 harmonisation of standards that apply to the organisation and working methods of test, certification and control bodies,
2 harmonisation of the standards that apply to the organisation and working methods of the state-accrediting bodies that give authorisation to the bodies mentioned in (1) and
3 harmonisation of the national systems that specify who is entitled to authorise the bodies mentioned in (1) (accreditation systems).
In order to guarantee the recognition of certificates for products coming under the directives after the "New Approach" (Official Journal No. C 10 from

16 January 1990), the conformity assessment procedure is stipulated from the outset and thus unified. ("Council Resolution on an Overall Concept for Conformity Assessment" of 21 December 1989). In December 1990, on the basis of this Global Approach for certification and testing, the Council of the European Union created the so-called "Modular Approach" of conformity assessment (see the CE conformity marking modified by the Council Resolution of 22 July 1993, cf. Official Journal L220 of 30 August 1993). It is implied in the "Modular Approach" that the manufacturer should be offered alternative options within Community law for demonstrating compliance with the EU technical harmonisation directives. In this approach, eight different modules, prescribing measures of varying expense and input of effort for quality assurance, testing and certification, are described. In all cases, compliance with the directive is documented by affixing the CE mark. The product has access to the free traffic of goods after it has been properly furnished with the CE mark. With this mark, the entrepreneur can be sure that he can sell his product in every EU member state without any further proof. The CE mark acts as kind of "passport" for goods travelling over Europe's borders. "CE is a 'ticket' for a product to enter the EEA" (Berghaus 1992, p. 213ff.)

The following are the most important and fundamental EC directives for the manufacturers of machines.
- EC Machinery Directive (98/37/EC). The machinery directive prescribes fundamental health and safety requirements that all machines brought into circulation within the EU have to satisfy. A machine as defined by this directive is "...linked parts or components, at least one of which moves, ... joined together for a specific application, in particular for the processing, treatment, moving or packaging of a material." Individual components which perform a safety function are treated separately in this directive.
- EC Directive on Electromagnetic Compatibility (89/336/EEC) (Directive 2004/108/EC, 15 December 2004). The Directive on Electromagnetic Compatibility applies to all apparatus that may cause electromagnetic disturbance. Examples include private radio and television receivers, medical and scientific apparatus and instruments, domestic appliances.
- EC Low Voltage Directive (73/23/EEC) (Directive 93/68 EC, 16 November 2005). Electrical equipment may be placed on the market only if, having been constructed in accordance with good engineering practice in force in the Community, it does not endanger the safety of persons, domestic animals or property when properly installed and maintained and used in applications for which it was made. To this end, the 11 safety objectives referred to in Annex I of this directive must be fulfilled.

In addition to the above-mentioned directives, there are also some other EC directives that can be considered important.
- EC directives on protection at work are issued in accordance with Article 137 (ex-118a) of the EC Treaty.

- The EC directives based on Article 95 (ex-100a) EC Treaty contain high-level stipulations.
- The EC directives based on Article 137 (ex-118a) of the EC Treaty specify minimum regulations.

It is possible for member states to enact regulations with a higher level of safety, for example the German accident prevention regulations. "Although the EC directives based on Article 137 (ex-118a) of the EC Treaty only regulate the permissible working conditions, their statements now and then affect the construction and placing of technical appliances on the market, as for instance demanded by the fifth individual directive for work with display screen equipment (90/270/EEC), e.g. that the screen should be stable, with no flickering or other forms of instability." (Petrick 1997)

4 Structure of EC harmonised standardisation

The European System for standardisation consists of three institutions:

- CEN (competent institution for standardisation in every field except that of electronics and telecommunications)
- CENELEC (competent institution for standardisation in the field of electronics)
- ETSI (competent institution for standardisation in the field of telecommunications)

CEN and CENELEC have merged under the roof of a common European standardisation institution which covers most standardisation fields. CEN and CENELEC are associations governed by Belgian law. Their members are the national standards bodies of EU and EFTA member states. These two associations develop "regular" European standards (EN), many of which come about as a result of consensus between the parties involved and have to be transposed into national standards. They also publish documents such as European prestandards (ENV) for which the consensus principle is restricted so that the process of standards preparation can be accelerated. International standards may be adopted into the European standards system in a relatively uncomplicated manner. The issuing of standardisation projects can also be transferred to international standards organisations. The EU may also issue a mandate for a certain standard to be drawn up. In short, it can be concluded that one of the goals of harmonised standardisation is to develop a comprehensive and consistent system of European standardisation, which has a considerable impact on international standards.

4.1 The structure of relations between the EC and European standards bodies

The most important elements in the relations between the EC committees and the European standards bodies are regulated in a series of official reference documents. Nicolas and Repussard 1994, p. 85 ff. summarise the most important aspects:

- Directive 83/189/EEC ("Information Directive") of 28 March 1983 dealing with a procedure for the provision of information in the field of technical standards and regulations. The "Council's conclusions" of 16 July 1984, which outline the future stan-dardisation policy of the EC.
- The "General guidelines for cooperation between the Commission of the European Communities and the European standards bodies CEN and CENELEC" of 13 November 1984 in which the Commission undertakes to refer as far as possible to European standards in its proposals for technical harmonisation.
- The "Green Paper on European standardisation and the Council's decision" of 28 January 1991 which contains a number of elements of the European standardisation system.
- The "Council's decision" of 18 June 1992 on "the function of European standardisation in the European economy".

4.2 The main organisations dealing with European standardisation

European standardisation is the remit of a number of major organisations. CEN and CENELEC, founded in 1961 and 1962 respectively, were set up as European equivalents to the international standards organisations, the ISO and IEC (Kleinemeyer 1997, p. 80 ff.) These organisations, CEN and CENELEC, are international non-profit making associations governed by Belgian law (Nicolas & Repussard 1994, p. 28 ff.). In addition to establishing "regular" European standards (EN), they are also responsible for what are known as "harmonisation documents" (HD) and European prestandards (ENV). At a national level, the EN must be transposed into a national standard and all conflicting national standards must be withdrawn. The implementation of an EN at national level is brought about by the publication of an identically worded national standard or by recognition in the form of publication of a notice of recognition in the Official Journal of a member state (Nicolas & Repussard 1994, p. 48).
Sometimes a rapid approach in standards development is required, for example, with regard to safety issues or in areas where there is a high level of innovation. In such cases, the development of standards using the highest possible degree of consensus must be optimised by having rapid availability of standards. ENVs are valid for five years. At the end of this validity period, an ENV should be converted into an EN or HD, or withdrawn.

It is the responsibility of the Administrative Board, which consists of only representatives of national standards bodies, to manage CEN. This Board reports to the General Assembly, the highest body responsible for directing CEN's activities and making changes to the statutes. The day-to-day standardisation work is carried out by the Central Secretariat.
Standards are actually developed under the auspices of the TC (Technical Committee) of CEN and CENELEC. The TCs, which consist of representatives sent by the national European standards organisations, are in turn managed by a Technical Secretariat. At European level, a great deal of the work is carried out by Technical Committees, which correspond to what are known as "mirror committees" at national level. The results obtained at national level are then discussed and decisions are reached at a higher European level.

There are three options when developing standards at European level, namely:

1 Confirmation of an existing reference document as a European standard through a "Unique Acceptance Procedure", for example in the case of an international standard that already exists.
2 Drafting of a standard by an international organisation such as the ISO, as regulated in the Vienna Treaty of June 1991 (Nicolas & Repussard 1994, p. 46 and p. 184 ff.) if it appears to be useful and feasible.
3 Commissioning a Technical Committee to prepare a draft for a European standard.

Under the so-called New Approach, the Commission gives a mandate to the European standards bodies to prepare a standard. There is a "standstill period" that should be observed, by the national standards bodies, during which a European standard (EN) is developed by CEN.

The goals of developing EU-wide harmonised standardisation are:

- Developing a conclusive, systematic and orderly structured standardisation system which also includes all necessary tasks.
- Drawing up European/international standards whenever there is an opportunity for standardisation to be coordinated in the member states.
- Preventing extra work by taking or finishing subjects that have already been covered in the same way by the ISO or IEC.
- Taking only urgent subjects for standardisation.

The European Telecommunications Standards Institute (ETSI) was founded by the EU Commission in 1988 as the successor organisation to the Conférence Européenne des Administrations des Postes et des Telecommunications (CEPT European Conference of Postal and Telecommunications Administrations). This organisation has responsibility for standardisation in the telecommunications sector at European level. The establishment of ETSI was based on the idea

that the private sector (industry and commerce) should be incorporated into the standardisation process in telecommunications. In the past only state institutions, i.e. national postal and telecommunications administrations, were involved in the telecommunications sector but the trend in recent years has been towards privatisation and deregulation in this area. In contrast to CEN and CENELEC, the participants involved in the development of standards in ETSI are not limited to representatives of national standards bodies but also include other interest groups such as administrative authorities, manufacturers, users, service providers, research & development bodies, network providers and consultants. By 2000, ETSI, already had 789 members from 52 countries. This organisation deals particularly with the following areas:

- fixed networks and Internet.
- mobile and radio communications.
- convergence of the fixed network, Internet, cellular network and radio.

Two meetings are held each year by the highest authority, the General Assembly. ETSI consists of an Executive Board, a General Secretariat that manages administrative duties, committees with certain fields of responsibility (e.g. finance) and an Operational Coordination Group. The standard development projects are conducted in Technical Committees, ETSI projects or partnership projects with other related organisations. ETSI finances its activities through a membership subscription. Decision-making in the standards development pro -cess is based mainly on the consensus principle. But it is also possible to apply the majority rule as well. Since ETSI comprises different interest groups, the cooperative approach is very valuable when dealing with all the actors in the telecommunications standardisation process.
ETSI's work on standardisation includes the European standards developed in the telecommunications series (EN), ETSI standards (ES) and technical reports (TR). By mid-2000, ETSI had already published more than 5,000 results and they are available on the Internet, where they can be downloaded free of charge.

4.3 Creating technical standards

Only the essential health and safety requirements for products have been regulated in the EC directives. The technical features are described in detail in the standards. Such technical standards are important although they do not have legal standing. Member states could conclude that particular products comply with the minimum requirements of the directive ("evidentiary presumption") if they comply with the technical standards.

4.4 Standard types

Based on ISO and IEC procedures, a distinction is made between "basic standards" (type A standards), "group standards" (type B1 and B2 standards) and "machine" or also "product standards" (type C standards). Such a structure is based on importance as well as the lex specialis principle. This means that if secondary standards describe a certain section of a primary standard more clearly, the secondary standards assume a position of priority (DIN 1994, Vol. 1, Chap. 2.3.3.2, p. 3 ff.).

Type A standards are standards that create basic statements on the safety of machinery and only have to be laid down once in a "basic standard". These also deal with basic concepts and principles for design, operating instructions, forms of expression, etc.

Type B standards are standards accompanied by safety-related issues that not only apply or are limited to one single machine or one single application, but can apply in a similar or equal manner to machines or applications and may be considered "group standards".

Type B standards are subdivided into:
- Type B1 standards with overriding safety aspects, for example: temperature, hot surfaces, ergonomic principles, hand/arm speed and safety distances.
- Type B2 standards for protective devices that can be used for various types of machines, for example: light barriers, emergency-stop switches, locking facilities for protective devices and two-hand controls.

Type C standards refer to "machine" or "product standards" where characteristic safety conditions are laid down or defined for groups of machines or individual machines.

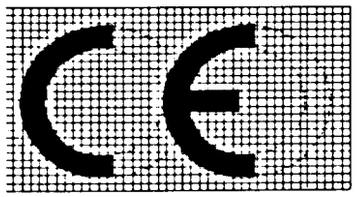
Standards are used as tools to aid the decision-making process when designing products or when standard types A and B apply. They support the preparation of standard type C, prevent the repetition of general definitions and ensure the necessary technical agreement between all C standards for specific safety issues (e.g. safety distances, preventing damaging effects from noise, etc.) and/or for safety-related machinery components.
The following quote from Petrick (1997) clarifies this:
"...for the manufacturer the essential safety requirements (Directives) are the starting point for the design and function of a product so as to conform with the regulations, and not the standards. This is of great importance, if, for example, a new kind of product is to be developed and brought into circulation" (Petrick 1997).

5 CE marking

5.1 The meaning of the CE mark

CE stands for "Communauté Européenne", the French translation of European Community. The CE mark is not a quality mark but an indication that the product complies with the directives. The CE mark and declaration of conformity are actually a technical passport for products, particularly those that are to be sold within the European market. A product that has a CE mark is presumed to comply with all directives applicable to the respective product. It has also already passed the underlying procedures for conformity assessment and the inspection based on the relevant harmonised standards. The procedures for CE marking, including the individual steps involved in acquiring the CE mark, will be discussed in the following sections.

The CE-Mark



- Minimum height 5 mm
- Suitable proportional size to the machine
- Clear and visible position
- Distinguishable from other marking

Figure: The CE mark (© pro-norm.de)

5.2 Stages in the CE marking procedure

The CE marking procedure consists of the following sequential stages:
1. Product definition
2. Monitoring of suppliers
3. Selection of the relevant directives and standards
4. Selection of a possible conformity assessment procedure
5. Establishing contact with a notified body (possible type examination)
6. Performance of the hazard analysis/risk evaluation
7. Verification that the demands from the directives have been noticed
8. Provision of information
9. Preparation of technical documentation
10. Examination and revision of the instruction handbook
11. Issuing of the declaration of conformity
12. CE marking
13. Access to market

CE marking procedure (1)

- Product definition
- Control of supplier
- Selection of relevant directives and standards
- Selection of possible conformity assessment procedure
- Selection of possible type of examination by contacting Notified Body
- Hazard analysis/risk assessment
- Verification of compliance with the directives

CE marking procedure (2)

- Provision of information
- Preparation of technical documentation handbook
- Examination and revision of the instruction
- Drawing up the declaration of conformity
- Affixing the CE mark
- Market access
- Series testing

Figure: CE marking procedure (© pro-norm.de)

5.2.1 Product definition

A precise and accurate product definition is important. It should cover the following items:
- Product designation
- Product characteristics
- Product components

It should first be established whether the product is subject to CE marking under EC directives.

Example:
Let us pretend that a manufacturer develops a new product and wants to put it on the market. If the new product is defined as a machine, the manufacturer needs to check whether it complies with the requirements of the EC Machinery Directive, which defines machinery as :
- "...an assembly of linked parts or components, at least one of which moves, with the appropriate operating gear, control and power circuits, etc., joined together for a specific application, in particular for the processing, treatment, moving or packaging of a material and whose only power source is not directly applied manual effort."
- "...an assembly of machines which, in order to achieve the same end, are arranged and controlled so that they function as an integral whole." Examples: transfer lines, production systems
- "...inter-changeable equipment modifying the function of a machine, which is placed on the market for the purpose of being assembled with a machine or a series of different machines or with a tractor by the operator himself in so far as this equipment is not a spare part or tool." Examples: dredging shovels, plough shares
- "Safety components" also come under the EC Machinery Directive.

In addition, the product must also be checked to ascertain whether it falls under other directives, regardless of whether a machine is involved. If it is a machine connected with one of the above-mentioned provisions, the particular machine must be be tested. The types of machinery and the required documents and marks to be tested are listed below:
- Machinery provided in a complete and ready-to-use state, so it can be entered into service directly; requires a declaration of conformity, a CE mark on the machine, instruction handbook.
- Machinery provided in parts that must be installed or assembled by the manufacturer before it is completed and can be entered into service, after installation or assembly and before delivery to the operator; CE mark must be affixed and declaration of conformity must be completed. The delivery must be accompanied by the instruction handbook.
- Machinery that is not complete and not ready to use as part of a whole machine or complex installation, which will be installed or assembled either by the purchaser or by a company commissioned to do the task; manufacturer's declaration and (partial) operating instructions for each separate machine assembly are required.
- Interchangeable equipment requires a CE mark, declaration of conformity and instruction handbook. For safety components, a declaration of conformity and an instruction handbook are necessary.

The intention is to provide information on the safe operation of the machine for its intended purpose without any hazard. The potential hazards as well as any special features of the machine should be clearly stated. The manual, regulation, instructions and notes are covered in the instruction handbook.

Safety declarations according to EC Machinery Directive

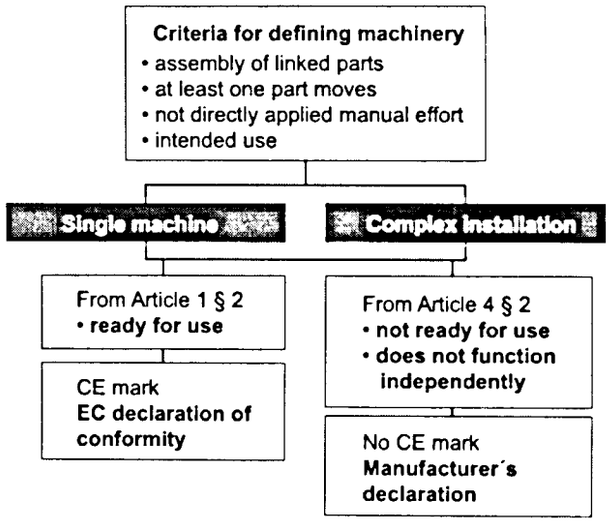


Figure: Product definition and safety declaration according to EC Machinery Directives (© pro-norm.de)

5.2.2 Monitoring suppliers

If a company manufactures a machine that is assembled from different components, which already have been furnished with the CE mark, the company is obliged to ascertain whether the suppliers have conducted the CE marking procedures properly. The company, as the party putting the machine onto the market, will be among the responsible parties in the event of any claims. If this company is unable to prove that the CE marking procedure had been properly conducted by its suppliers, this company must be partly responsible for any claims that arise and could be called upon to accept part of the liability.

5.2.3 Searching for directives, laws, and standards

Health and safety requirements for products are the main issues regulated in the directives according to Article 95 (ex-100a) EC Treaty. For machinery or complex installations, the following directives are relevant:
- The EC Machinery Directive
- The EC Directive on Electromagnetic Compatibility (EMC)

- The EC Low Voltage Directive

The EC Machinery Directive
Basic health and safety requirements as well as a description of possible hazards constitute the basic contents of the EC Machinery Directive. The main principles are the following:
1 The main health and safety requirements must apply to the manufacturer if the relevant hazard does actually exist under the foreseen circumstances. However, the following requirements apply in any situation:
   - Safety integration principles
   - Marking requirements (see DIN EN 50099)
   - Requirements for the instruction handbook
2 Since the requirements are mandatory, if the present state of the art does not meet the set objectives, the machinery must be optimally designed and built so that it complies as closely as possible with those requirements.
3 Additional requirements for particular groups of machinery and hazardous products are outlined in Sections 2 to 6 of Annex I.

A machine must fulfil all the main requirements, regardless of the section under which it falls. Sometimes the requirements in Annex I of the directive for health and safety expand on what has been mentioned in previous accident prevention regulations. These should be considered by the manufacturer. For example, the EC Machinery Directive (89/392/EEC) has undergone three amendments by three other directives since 1989, and in June 1998 a new version of the Machinery Directive was issued.

EC Machinery Directive (structure)

Chapt. 1	Scope Placing on the market
Chapt. 2	Freedom on movement
Chapt. 3	Certification procedure
Chapt. 4	CE mark
Annex I	Essential health and safety requirements relating to the design and construction of machinery and safety components
Annex II	Contents of the safety declarations A Contents of the EC declaration of conformity for machinery B Contents of the manufacturer's declaration C Contents of the EC declaration of conformity for safety components placed on the market separately
Annex III	CE conformity marking
Annex IV	Types of machinery with high hazard levels and types of safety components for increased requirements A Machinery B Safety components
Annex V	EC declaration of conformity technical documentation

Figure: EC Machinery Directive structure (© pro-norm.de)

Low-Voltage Directive (73/23/EEC)

In 1973, the Council of the European Community developed a directive on electrical equipment for use within certain voltage limits to counter the trade barrier resulting from the different formulations in individual member states. It stated that harmonised standards had to be met for electrical equipment. With effect from 31 December 1994, it became mandatory for the equipment to conform to the applicable EC directives. On 1 January 1997, the conformity assessment procedure was amended by the CE Marking Directive (93/69/EEC).
The directive deals with electrical equipment using a voltage rating between 50 and 1,000 V for alternating current and between 75 and 1,500 V for direct current. The equipment listed in Annex II of this directive covers the exceptional equipment and phenomena.

Electrical equipment that is to be put on the market must be built or constructed in accordance with good engineering practice. If properly installed, maintained and used, the equipment must not constitute a threat to the safety of persons, domestic animals or property. There are 11 safety objectives listed in Annex 1 of the directive that should be fulfilled.
If machinery contains electrical equipment, the manufacturer of such machinery should comply with this directive. The safety requirements that should be fulfilled for machinery containing electrical equipment are regulated in EN 60204-1 "Electrical equipment of machines - Part 1: General requirements", which was replaced by the CE marking with effect from 1 January 1997. The following requirements apply, irrespective of the risk analysis:

- Category of the stop function for the emergency stop function
- Use of a two-hand control device of the type defined in the standard (see EN 574)
- Implementation of safety functions using electrical/electronic control systems in accordance with the safety category of the control system (see EN 954-1)

The Electromagnetic Compatibility Directive - EMCT

This directive, usually referred to as the "EMC Directive", is part of "Council Directive 89/336/EEC of 3 May 1989 on the approximation of the laws of the Member States relating to electromagnetic compatibility". Since 1 May 1989, this directive has been amended by directives 91/263/EEC, 92/31/EEC and 93/68/EEC.
This directive, which stipulates the conditions for exhibiting, operating and putting equipment on the market, applies to equipment or apparatus which could generate electromagnetic disturbance or whose performance is liable to be affected by such disturbance. When properly installed, maintained and used as intended, such equipment must meet the safety requirements pursuant to Article 4 directive 89/336/EEC. The compliance must be certified by the manufacturer, his authorised representative or a responsible office. The equipment, its packaging and the accompanying papers are marked accordingly.
Annex I of the directive deals with the declaration of conformity, Annex II with test bodies and Annex III with the essential protective requirements.
The manufacturer is responsible for issuing the EC declaration of conformity or producing a report or documentary evidence from an authorised and notified body. To ensure compliance, the following standards should be applied:

- The corresponding EMC standards relating to the machinery or
- The minimum requirements of the basic standards EN 50081 (EMC; generic emission standard) and EN 50082 (EMC; generic immunity standard).

5.2.4 Sources of information

The following is a selection of the most important addresses with regard to Official Journals, EC directives or European standards. The latest status of EC harmonised standards can be obtained from national standards bodies or CEN. Databases are also available in some member states. The Internet can also be used to search for harmonised standards relating to the product. The following are the names and addresses of institutes, bodies or publications that deal with standards.

CEN Comité Européen de Normalisation Central Secretariat,
Rue de Stassart 36B-
1050 Bruxelles (Brussels)

Official Journals of the EC Germany
Bundesanzeiger Verlags-Gmbh
Breite Strasse 78D-
50667 Köln (Cologne)

Web sites of the European Commission.
http://europa.eu.int/scadplus/leg/en/lvb/l21001a.htm
http://europa.eu.int/comm/enterprise/regulation/index_en.htm
http://www.newapproach.org/
Guidelines for the transposition of the European Commission directives based on the New Approach and the Global Approach.

5.2.5 State of the art

A number of stages are recommended to ensure that the CE marking procedure runs smoothly. The stages are arranged in order so it is advisable to follow them sequentially.

Generally acknowledged good engineering practice
Generally acknowledged good engineering practice covers written or verbal detailed descriptions of processes, appliances and operating methods which are believed, according to prevailing opinion, to be appropriate for achieving the legally prescribed objective. This practice is proven or will be proven to be viable. Economic aspects must be considered in any legal considerations for appropriately set objectives.

State of the art
State of the art is the development stage of advanced processes, appliances and operating methods. It is peer reviewed by the leading experts in the respective field to be suitable to achieve the legally prescribed objectives. The

economic aspects are only secondary when considering the appropriateness of the set objectives. The method or one of the equivalent statuses must have proven its practical value or should have been successful in practice.

State of science and technology
The state of science and technology is the stage in the development of advanced processes, appliances and operating methods, based on the latest science and technology, that has been proven to be capable of safely achieving the legally prescribed objectives. Economic aspects do not play any role in legal considerations, since, in the field of health and safety, hazard prevention is more important than economic aspects.

5.2.6 Conformity assessment

The compliance of a product, process or service with the essential legal requirements is tested or proved through conformity assessment. The Commission has systemised various certification procedures in the "Global Approach for certification and testing". It has also formulated the so-called certification modules, which consist of independent, indivisible and complementary modules. The modules are designated by the letters A to H. If a procedure is not prescribed in the relevant directives, the manufacturer is free to choose the type of conformity assessment. Declaration by the manufacturer or module A is the most widely selected. Annex IV of the Machinery Directive lists machinery and safety components with a high hazard potential. If such machines or safety components are not built, or only partially built, in agreement with harmonised European standards, the manufacturer must arrange for a model of the machinery to be examined.

1 The aim of conformity assessment
All conformity assessment activities are intended to test or to prove whether the product, process or service complies with the essential legal requirements.

2 Global Approach and the decision on modules
In the "Global Approach for certification and testing", the Commission systemised many certification procedures and formulated so-called certification modules (certification elements) containing independent, indivisible and complementary modules, designated by the letters A to H.
Modules A, G and H cover both the development and production phases. Module B is a combination module. It can be combined with modules C, D, E and F. The directives relating to the product specify the module or modules to be applied by the manufacturer for the respective product. If the relevant directives do not prescribe the procedure for a certain product, the manufacturer of this product is free to choose the conformity assessment procedure to be applied.

The most widely used is module A, the manufacturer's declaration. The costs and time associated with the conformity assessment procedure depend on the type of module selected. Module A is the simplest and least costly whereas module H is the most expensive.

3 EC type examination ("third-party certification")
Third-party certification means certification of compliance with the essential requirements of the directives performed by an outside independent body.
Annex IV of the Machinery Directive contains a list of machinery and safety components with high hazard potential (e.g. portable chain saws for woodworking).

The conformity assessment procedure for EMC

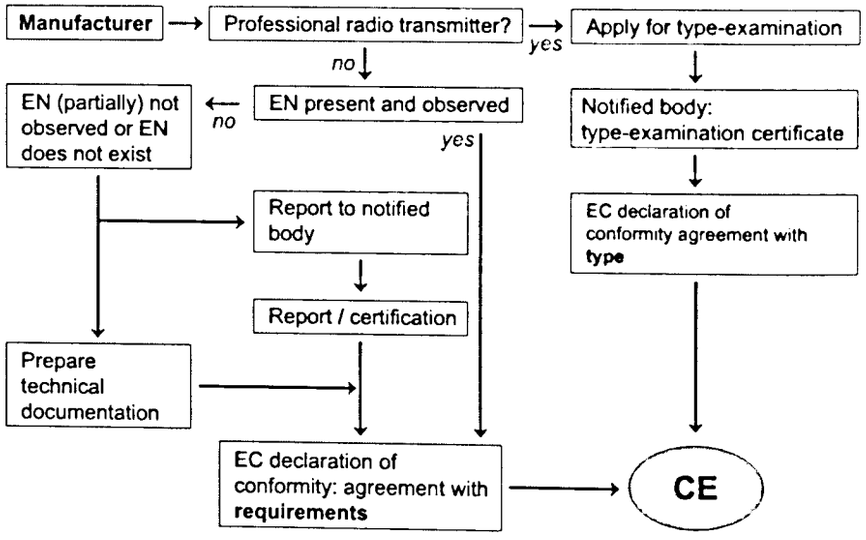


Figure: The conformity assesment procedure for EMC (© pro-norm.de)

If such machines or safety components are not built, or only partially built, in accordance with harmonised European standards, the manufacturer must provide a model of the machinery for type examination. The application for a type examination by a "notified body" must be accompanied by the information listed under item 2 in Annex VI of the Machinery Directive. In the examination, the "notified body" observes the documents and the function of the machinery

model to analyse whether the design and construction have already met the essential requirements mentioned in the Machinery Directive.
The notified body will issue an EC type examination certificate at the end of examination process if the machinery model has successfully passed the examination. The notified body should be informed of all planned modification and it will assess whether the certificate is still valid.

The Modular Framework

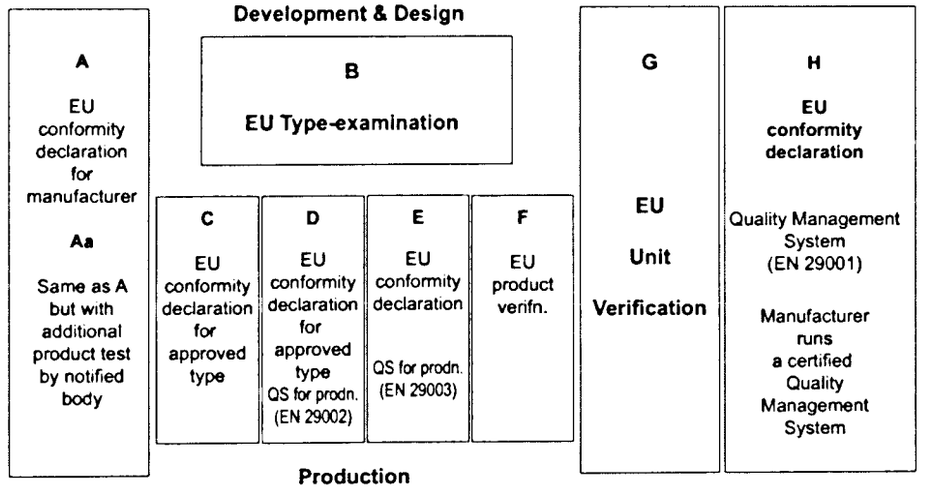


Figure: The Modular Framework (© pro-norm.de)

5.2.7 Hazard analysis according to the Machinery Directive

The hazard analysis is used to identify potential hazards and to introduce the countermeasures required to prevent such hazards. The aim is to ensure that unexpected hazards do not occur during use of the product. Following the risk evaluation and safeguarding measures, an examination of residual risk is conducted. This determines whether the residual risk is still acceptable or whether a warning should be attached to the product. The manufacturer should apply certain principles when choosing the appropriate method of hazard elimination; these are known as "three-tier principles":

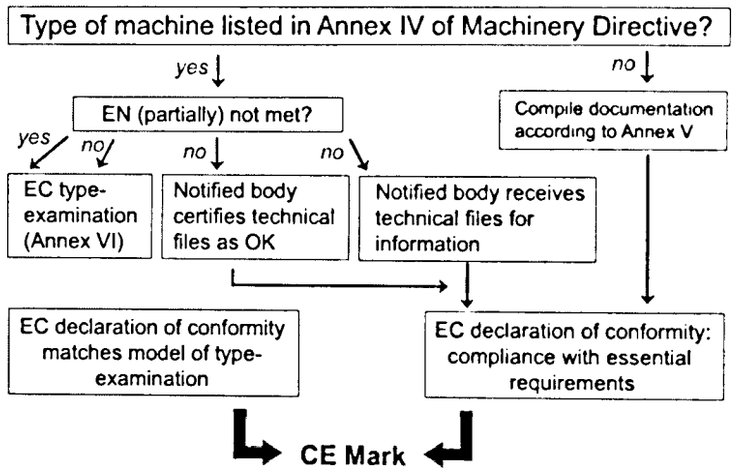


Figure: Decision-making tree for EC type-examination (© pro-norm.de)

1 Hazard removal or minimisation (incorporating the safeguarding measures into the development process by modifying the design)
2 Installation of the required safeguarding measures to counter the non-removable hazards listed under item 1.
3 Information to the user on all residual hazards (special safety instructions) caused by the ineffectiveness of the safeguarding measures mentioned under item 2 and information on any special training and necessary protective equipment that may be required by the operator.

1. The structure of risk assessment
Risk assessment is a sequence of logical and systematic steps designed to investigate and identify the possible hazards caused by machinery. If necessary, a risk assessment will be followed by risk reduction in accordance with Clause 5 of DIN EN ISO 12100. By repeating the procedure using an iterative process, the required level of safety will be achieved, hazards will be eliminated and safeguarding measures will be introduced.

2. Scope and implementation
When a particular type of machinery requires a type C standard, a hazard analysis, based on DIN EN 414, will be carried out. The manufacturer should then refer to this standard. If appropriate measures are introduced for a particular hazard, a remedy description is sufficient for compliance with the C standard. However,

if such a standard is not available, the manufacturer should determine all the requirements and precautions relating to the nature of the product.
Specific information on hazard analysis can be found in the following standards:
- DIN EN 292 Safety of machinery: basic concepts, general principles of design.
- DIN EN 414 Safety of machinery: rules for the drafting and presentation of safety standards
- DIN EN 954-1 Safety of machinery: safety-related parts of control systems
- DIN EN 1050 Safety of machinery: principles for risk assessment

3 Evaluating the risk
Risk evaluation includes:
- The greatest foreseeable severity of this injury or damage to health (DIN EN ISO 12100)
- The probability of an injury or damage to health occurring, related to the frequency and length of time that a person is exposed to a hazardous situation (DIN EN ISO 12100)
- The possibility of avoiding hazards (DIN EN 954-1)
- Other factors as outlined in DIN EN 1050

5.2.8 Documents for the EC declaration of conformity

The "technical documentation" for a product consists of two groups:
- Manufacturer's documentation, also known as "internal documentation", containing design and production documents, test reports, etc.
- User documentation, also known as "external documentation", containing instructions for operating, installing and maintaining the machinery.

The manufacturer should complete all necessary documents before submitting the EC declaration of conformity. It must be possible to present all the documents to the national authorities of member states if they wish to check the correctness of the EC declaration of conformity. In the case of series manufacturing, internal quality assurance could guarantee the compliance of the series with the main requirements of the Machinery Directive.
An increasing number of people with a basic level of education are working with complicated or complex machinery. It is the obligation of the manufacturer to provide instructions with the machinery. However, it should be borne in mind that this may not be sufficient.
The technical documentation should comply with Annex X of the Machinery Directive and be retained for ten years. This documentation should also be in one of the official languages of the EC. The instructions for the machinery must be written in the language of the country where the machine will be used. In addition, the machinery must be made available with a copy of the original version

of the instructions in one of the EC languages. This also applies to the declaration of conformity or the manufacturer's statement.

1 Technical documentation

The "technical documentation" for a product consists of two groups:

- Manufacturer's documentation or "internal documentation"
- User documentation or "external documentation"

The manufacturer's documentation includes design and production documents, test reports, etc. The user documentation contains instructions for operating, installing and maintaining the machinery, etc.

Technical documentation has both internal functions and external functions. For internal use, the technical documentation contains descriptions and records on the machinery's properties, functions and hazards. It also describes compliance with the laws, directives, regulations and standards as well as with the client's requirements. The external function of the technical documentation is to provide instructions for users or operators, documentation for test centres, information for sales negotiation as well as proof for courts and insurance companies in the case of claims. The instruction handbook is an important part of the technical documentation.

A record of safety schemes must be kept as part of the technical documentation. It is obvious that decisions made to eliminate or reduce hazards within the safety schemes must be carried out. For machinery produced in series, the manufacturer must show which of the internally agreed measures can guarantee compliance with the respective directives.

2 The instruction handbook

Main functions:

The main functions of the instruction handbook are as follows:

- The instruction handbook (original and its translation in the language of the user's country) is an important component of the supply schedule.
- It is a prerequisite for the EC declaration of conformity or EC type examination and it is provided in addition to the machine's CE mark.
- Complying with the content of the instruction handbook should prevent or protect the user or operator from any hazards.
- It provides guidelines to enable the operator to use the machine as effectively and safely as possible and to gain the full functional advantages of the machine.
- It can be used for corporate identity purposes in marketing, particularly when communicating with users.

Requirements for the instruction handbook

The instruction handbook should cover information related to the following issues:

1) Intended use of the product

- Manufacturer's information on the normal or appropriate use of the machine based on its design, construction and function
- Potential misuse
- Warning of risks and residual hazards
- Warning of potential risks if the product is not used properly

2) Inspection and servicing

- The type of inspections and services and the intervals between them in terms of safety
- Reference to wearing parts and criteria for their replacement
- Reference to suitable spare parts, tools and possible maintenance contracts

3) Information for safe operation (minimum requirements):

- Putting into service
- Use
- Handling
- Installation
- Assembly/dismantling
- Adjustment
- Maintenance, including service and elimination of faults during the operating process

4) Language

- Written in the language(s) of the country where the machine will be used
- The machinery must be accompanied by the instructions written in the original language and a translation in the language(s) of the country where the machinery will be used
- Maintenance instructions for the manufacturer's personnel should be written in one of the Community languages

5) Drawings, diagrams and all instructions, particularly with regard to the safety of

- Services
- Inspections
- Checking of correct operation
- Repair of the machinery where applicable

6) Information on noise

- Information on airborne noise emissions by the machinery (actual value or value established from identical machinery)

Examination of the instruction handbook
The requirements that instruction handbooks should be didactically correct and target-oriented are mentioned in EC directives, laws and regulations and are insisted upon by occupational insurance and consumer associations. This is important, as more and more people with a basic level of education are now working with sometimes very complex and complicated machinery.
The assessment has been developed to allow the manufacturer to check whether the instruction handbook complies with all specifications for instructions. The following criteria are assessed:
- Structure
- Comprehensibility
- Visualisation
- Operator safety
- Presentation.

In terms of structure, the instruction handbook should be easy to follow. The comprehensibility concerns both the linguistic aspect and completeness of the instructions. The visualisation is assessed in terms of the use of verbal and visual communication, including the balance achieved between the two methods. Attention should be paid to the illustrations and the respective text. Operator safety is an important aspect. Poor quality language and drawings will make the entire instruction handbook incomprehensible. A technically safe product may become hazardous if accompanied by an unintelligible instruction handbook. The consequences may involve considerable liability risks for the manufacturer or the operator. Finally, presentation is as important as the other criteria in producing a good instruction handbook. The best photographs will not mean anything if they are printed on poor quality paper and the same is true if the most important information is set in minute type.
To summarise, it is important that the instruction handbook is error-free, complete, unambiguous and honest. It should describe everything that the user needs to know about operating the machinery in a safe manner. It also should include warning notes on the intended use as well as foreseen misuse. The instructions should be described precisely and clearly and include the necessary cautions regarding handling and use of the product (transport, storage, commissioning, use, maintenance, inspection, cleaning, repair, disposal, etc). Honest means clear and comprehensive information on the possible hazard and the residual risk.

5.2.9 Declaration of conformity

The declaration of conformity certifies that the machinery to be put on the market complies with the essential requirements stated in Annex I of the Machinery Directive. If other EC directives also apply to the machinery, it should

be declared and certified that the machine complies with the requirements as mentioned in the respective directives.
As described in the EC Machinery Directive, the EC declaration of conformity must be issued and prepared for all machinery, even for one-off models, specified machines, interchangeable equipment as well as for each individual machine from a series, regardless of whether the machines will be employed for commercial, industrial or private use. This obligation also applies to machines produced for in-house use only.

1 Legal basis
Article 4, Paragraphs 2 and 3, Article 5, Paragraph 1, Articles 7, 8 and 10 of the Machinery Directive and Annexes II, III and V of the Machinery Directive are the legal basis for certification and the declaration of conformity.
According to Article 8, Paragraph 1 of the Machinery Directive, the manufacturer should file a declaration of conformity based on the specified model for each machine or safety component. The CE mark will only then be affixed to the machine. If the machinery does not function independently, a manufacturer's declaration is required.
In summary, it could be said that the EC declaration of conformity must be issued by the manufacturer for every "single machine", "assembly of machines", "interchangeable equipment" and "safety component". If the machine cannot function independently, the manufacturer's declaration must be submitted.

2 EC declaration of conformity
The EC declaration of conformity must contain the following particulars:
- Name and address of the manufacturer or his authorised representative established in the Community
- Description of the machinery
- All relevant provisions complied with by the machinery
- Where appropriate, the name and address of the notified body to which the file has been forwarded in accordance with Article 8 (2) (c) dash one of the Machinery Directive
- Where appropriate, the name and address of the notified body that has carried out the verification referred to in Article 8 (2) (c) dash two
- Where appropriate, a reference to the harmonised standards
- Where appropriate, the national technical standards and specifications used
- Identification of the person empowered to sign on behalf of the manufacturer or his authorised representative.

The EC declaration of conformity for safety components must contain the following particulars:
- Name and address of the manufacturer or his authorised representative established in the Community
- Description of the safety component
- Safety function fulfilled by the safety component, if not obvious from the

description
- Where appropriate, the name and address of the notified body and the number of the EC type examination certificate
- Where appropriate, the name and address of the notified body to which the file has been forwarded in accordance with Article 8 (2) (c) dash one
- Where appropriate, a reference to the harmonised standards
- Where appropriate, the national technical standards and specifications used
- Identification of the person empowered to sign on behalf of the manufacturer or his authorised representatives.

By outlining an EC declaration of conformity, manufacturers officially state that the machinery they have put on the market complies with the fundamental requirements of Annex I of the Machinery Directive. If other EC directives have to be applied to the machinery, the declaration of conformity is used by manufacturers to announce and confirm that the machinery they have put on the market also complies with the fundamental requirements of the other directives.

The manufacturer therefore bears individual responsibility, even if an independent third party has been brought in, that his machinery is compliant with the applicable EC directives. The obligation to issue and draw up the EC declaration of conformity applies to all machinery, as described in the EC Machinery Directive, including such machinery produced as a one-off model, special machines and "interchangeable equipment", as well as each personal machine from a series, regardless of whether the machines are employed for commercial, industrial or private use.
Furthermore, this obligation also applies if machinery is produced for domestic use only. In this case it does not matter who is named as the "manufacturer". The manufacturer can be the installation company, the dealer, the rental company or the service firm. He then submits the EC declaration of conformity, which must cover every machine that is delivered.

3 Manufacturer's declaration
According to Article 4, Paragraph 2 of the EC Machinery Directive, the manufacturer's declaration must contain the following information:
- Name and address of the manufacturer or his authorised representative established in the Community
- Description of the machinery or machinery parts
- A statement that the machinery must not be entered into service until the machinery into which it is to be incorporated has been declared in conformity with the provisions of the directive
- Identification of the person signing

By drawing up the manufacturer's declaration, manufacturers confirm that the product concerned is intended exclusively to be combined with other machinery to produce an "entire machine" or "assembly of machines" and must not

be operated independently of these. The manufacturer's declaration must be drawn up for all "machinery that cannot function independently". Naturally, such "machinery that cannot function independently" must in itself meet the terms of the essential requirements of the Machinery Directive and all other applicable EC directives. Where appropriate, the manufacturer must state in the accompanying instruction handbook, in agreement with the user (operator), which safety instructions have to be observed when installing or assembling his products to make an "entire machine" or "assembly of machines". In principle, the manufacturer's declaration contains the same information as the declaration of conformity (see above). It also contains an additional statement that the machinery must not be entered into service until it has been stated that the "entire machinery" into which it is to be integrated complies with the requirements of the directive.

4 Affixing the CE mark
By signing the EC declaration of conformity for a machine, the manufacturer is entitled and obliged to affix the CE mark to the machinery. This means that the manufacturer must also attach a CE mark to every machine covered by an EC declaration of conformity. Only one CE mark may be attached to a machine unless "interchangeable equipment" is fitted to a machine. If machines are assembled into the whole machine or "installed" with individual machines that still function independently of one another, a CE mark must be affixed to each machine.

5.2.10 Market access

After all the procedural stages have been completed and verified and the CE mark has been affixed, the product can now be made available for sale in the European internal market. The CE mark allows free market access throughout the European Community. However, there is still an obligation on the manufacturer to continuously ensure that the safety requirements are being fulfilled in line with the latest requirements. The manufacturer should bear in mind the following questions:
- Are there any new directives?
- Have any harmonised standards been amended or have new ones been issued?
- Have any modifications been made to the product or production?
- Have there been any reports from the market of accidents or incidences of damage that may affect safety?

1 Placing on the market
Placing on the market occurs when a product covered by a directive is made available for sale and/or use on the European Community market. The product is placed on the market when it is sold and/or used on the common market for

the first time, irrespective of whether it was manufactured within the European Community or imported from a non-EU country. As the phrase "placing on the market" only refers to the first time a product is made available within the European Community, the directives only apply to new products in the case of products manufactured within the European Community. However, in the case of imported products from non-EU countries, the directives apply to both new and used products.
A product can be placed on the market by the manufacturer, his authorised representative established in the EC or the importer within the EC. There are two variations:

- Transfer of a product: the manufacturer, his authorised representative established in the EC or the importer within the EC passes title of the product to the person selling it on the EC market or transferring it to the consumer or end-user as part of a transaction, whether against payment or not, whereby the legal basis of this transfer is of no consequence. It may involve a sale, a loan, rental, leasing, a gift or any other legal transaction. At the time of the transfer, the product must comply with the requirements of the directive.
- Offer of transfer: the manufacturer, his authorised representative established in the EC or the importer offers a product directly proposed for the end-user in his own distribution chain. From this moment on, the product must comply with the requirements of the directive.

The following cases do not involve placing products on the market:

- The manufacturer transfers a product to his authorised representative or the importer; in this case the manufacturer may carry out all the necessary work to establish conformity of the product with the directive.
- A product intended for re-export is imported into the EC within the framework of the convention for cross-border processing.
- A product proposed for export to a non-EU country is manufactured within the EC.
- A product for display at trade fairs and exhibitions.
- A product placed in the manufacturer's or the importer's warehouse is not automatically regarded as having been placed on the market. The regulations for placing products on the market apply to each individual product, regardless of the time and place of manufacture and regardless of whether it is produced individually or in series production.

2 Entering into service
Entering into service describes the condition whereby a product that is covered by the directives is employed for the first time by its end-user on the EC market. This means that entering into service occurs when a product is first employed or put to use. If a product is produced for the manufacturer's or the importer's own use or is imported from a non-EU country for a similar purpose, it is difficult to distinguish between placing on the market and entering into service. If a product is part of a machine manufactured in series or a consumer good, which can be used directly when it has been placed on the market, "entering the product into service" is regarded as "placing the product on the market".

3 Series testing
The CE mark is only valid for the individual machine. It is the obligation of the manufacturer to continuously check whether the safety requirements are still in line with the latest requirements by always asking the following questions:

- Are there any new directives?
- Have any harmonised standards been revised or have new ones been issued?

5.2.11 Market surveillance

Using a declaration of conformity, the manufacturer must demonstrate that his product complies with the necessary health and safety requirements of the relevant EC directives. Non-compliant products may not be sold in the European internal market. If such a requirement is not fulfilled, the equipment or machinery will be removed or withdrawn from the market or shut down. In addition, the EC Product Liability Law provides for a penalty in the form of fines to be imposed for non-observance of EC directives. The amount of the fine depends on the severity and extent of the transgression. This means that failure to observe the EC Machinery Directive and its regulations represents a barrier to trade and leads to serious competitive disadvantages.

1 Legal basis
Market surveillance is performed by the national authorities. In Germany, for example, the following market surveillance applies:

- In the case of EC directives implemented under the Geräte- und Produktsicherheitsgesetz (Equipment and Product Safety Act - GPSG) the responsibility lies with the authorities of the federal states
- The area covered by the EMC Directive falls according to the German 'Gesetz über elektromagnetische Verträglichkeit von Geräten' (Electromagnatic Compatibility of Equipment Act - EMVG) under the responsibility of the Bundesnetzagentur (Federal Network Agency).

When directives have been violated, the above-mentioned offices or authorities have the power to

- Impose penalty or fines
- Remove or withdraw non-compliant equipment from the market

The European Commission in Brussels must be notified in all cases and it will inform all EU countries of the prohibition on sales. This means that the equipment cannot be sold anywhere in the European Community.

2 Consequences of misusing the CE mark

The following are the consequences of misusing the CE mark:

- Penalty (€30,000 under the GPSG and €50,000 under the EMC Directive/ EMVG)
- Supervisory authorities (for the Machinery Directive, e.g. the factory inspectorate) may forbid the use of the machines
- Customers may claim for damages as a result of production losses
- Insurers are not liable for settlement in the event of a claim for damages

3 Procedure for "removal from the market"

If a member state finds out that machinery with the CE mark or a component with an EC declaration of conformity poses or threatens to pose a safety hazard to persons, domestic animals or property during its intended use, it first takes all the necessary measures. For instance, it may demand a suitable safety-related engineering solution or remove the machinery from the market, prevent the machinery from being sold or prohibit it from being operated. An accurate justification of the national measures must be provided to the affected party. Furthermore, the affected party must be informed of its rights to legal redress and applicable time limits.

The member state must promptly notify the European Commission of the measures taken, together with the justification, so that the matter can be followed up at European level. In particular, the justification must specify whether the essential requirements were not fulfilled, whether the EC harmonised standard was applied insufficiently or whether the EC harmonised standard itself was insufficient. The Commission then immediately contacts all the affected parties, i.e. including the manufacturer, and, where appropriate, the notified body, and then makes its decision.

If the Commission is of the same opinion as the member state, it will inform other member states accordingly. The member state in whose territory the manufacturer is based then takes suitable measures against the manufacturer. If the Commission rejects the member state's opinion, the member state actively involved in the matter and the manufacturer will be informed. If the active member state, in its justification, has specified an error in the EC harmonised standard itself and still insists upon this in spite of the rejection, the Commission will authorise the Committee on Technical Regulations and Standards to perform an examination in accordance with Article 6, Paragraph 1 of the EC Machinery Directive. If any of the affected parties refuse to accept the decision, they may take legal action via the European Court of Justice.

4 The supervisory authorities

Although the supervisory authorities have been heavily overloaded with monitoring the implementation of all directives, they have found more and more cases of violation in the past three years. This is partly due to routine investigations and partly a result of selected random sampling. The factory inspectorates perform special campaigns at regular intervals, focussing on areas with

relevance to safety. In 1996, for instance, they investigated machinery for compliance with the regulation governing noise emission. As the Machinery Directive specifies that the instruction handbook must include figures for the noise level, they came across many cases of infringement. A glance at the instruction handbook is all that is needed to find any possible shortcomings. This does not even require the supervisory authorities to visit the enterprises.

The German Bundesnetzagentur, for instance, demands that the declaration of conformity or technical documents be submitted for unsystematic samples in the field of electromagnetic compatibility. As descriptions of the measures actually carried out have shown, they facilitate experts in rapidly identifying any shortcomings. The Bundesnetzagentur now carries out inspections on a large scale. Using a format which is based on product standards and corresponds to the quantity of the appliances on the market, they personally examine some 40,000 appliances per year and check measurements on approximately 3% of the equipment types.

Even in 1996, as many as 10,060 appliances were subjected to close inspection. Cause for complaint was found in 33% of total appliances. The types of complaint can be broken down as follows: 11% had technical defects, in 61% of cases the marking was malfunctioning and in 28% of cases the CE mark was either lost or incorrectly affixed. In some cases, warnings were issued, administrative charges levied and compulsory fines imposed. In any case, where contravention of the Law on Electromagnetic Compatibility is established (EMVG), the person putting the equipment on the market will be invoiced for the administrative expenses, which generally amount to (€500). Also warnings may be issued and fines of up to (€50,000) may be compulsory. These may be accompanied by an order to withdraw the equipment from the market or carry out modifications.

The purpose of the BAPT inspections, which were first carried out in their complete format in 1997, is to achieve, through the threat of follow-up measures, a lasting effect on the unacceptable quality of the declaration of conformity and the lack of care taken by some enterprises when putting products onto the market.

Trade fairs are certainly also appropriate events for investigating conformity with regulations. In any case, the CE mark and the declaration of conformity will be required and if the machinery is in use, the instruction handbook too.

6 Strategies for implementing directives in company standards

As the application of EC directives in countries that are not members of the European Union is not laid down by law, a somewhat dissimilar method can be adopted when working with these directives. If products are intended for sale in Europe, they have to fulfil the requirements of the directives. Basically, there are two dissimilar approaches when it comes to satisfying the main safety requirements. Neither approach is discussed in detail, but simply introduced. The implementation of these methods depends on the existing procedures and resources within the company as well as on any prior experience in dealing with directives.

6.1 Preparing company standards on the basis of the directives

The preparation of company standards based on the text in the directives presupposes experience in dealing with the translation of commonly formulated demands into comprehensive requirements. The work of incorporating the provision of these common demands together with the basic safety standards (type A standards) and group standards (type B standards) must be performed by suitable professional staff (legal experts, standards development staff, environmental experts, etc.)

6.1.1 Preparing company standards on the basis of harmonised standards

The application of European standards also remains voluntary for manufacturers of products from member states of the European Union. Since the harmonised product standards (type C standards) have been prepared on the basis of the requirements set forth in the directives, the fundamental safety standards and group standards, it may be alleged that the main safety requirements have been satisfied when European standards are used.
This presumptive result is laid down in all directives that have been prepared on the basis of the New Approach. This deductive process can naturally also apply to manufacturers from non-EU states who label their products with the required conformity marks. For this reason, the incorporation or adoption of European standards into company standards is a step towards a strategy that complies with the requirements of EC directives.
If the process of standardisation conformity has been conducted, which is required by the individual directives and varies according to the particular case, the products may be furnished with the essential mark and displayed, offered

for sale, sold and entered into service all the way through the European internal market.

7 Concluding remarks

The CE mark is a requirement in all EU member states, EFTA states and member states of the European Economic Area for the initial placing on the market or entering into service of products for which a CE mark is required under the EU directives listed below.
The CE mark was created to ensure the free movement of products for consumers within the European Community (EC). The CE mark is also frequently referred to as a "passport" for the European internal market. The abbreviation CE stands for Communauté Européenne (French for European Community). The CE mark is again and again incorrectly referred to as a "quality mark".
EC directives drawn up pursuant to Article 95 of the EU Treaty (known as internal market directives) stipulate certain minimum health and safety requirements for numerous products, which these products must attain as a minimum. A product can only be placed on the market and entered into service if it complies with the provisions of all the EU directives applicable to the product and if the conformity assessment procedure has been performed in accordance with the applicable EU directives.
Regulations designed to further technical harmonisation within the EU internal market have been drawn up within the framework of the New Approach concept for product regulation and within the framework of the Global Approach for the conformity assessment.
By using the CE mark, the manufacturer is confirming the compliance of the product with the relevant EU directives and observance of the minimum requirements stipulated in such directives. The hazard analysis, the technical documentation and the conformity assessment procedure constitute the essential elements of the Machinery Directive.

Text of the Directive 94/9/EC

Directive 94/9/EC OF THE EUROPEAN PARLIAMENT AND THE COUNCIL of March 1994
on the approximation of the laws of the Member States concerning equipment and protective systems intended for use in potentially explosive atmospheres
www.europa.eu.int/

Figure: Text of the Directive 94/9/EC (Source: www.europa.de)

The manufacturer of the product is generally responsible for this mark (for non-EU manufacturers, an authorised representative based in the EU is required). If the manufacturer outside the EU is not able to meet his obligations, this obligation transfers to his authorised representative in the EU or the importer or ultimately the vendor (colloquially known as the seller).

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http://www.newapproach.org/

Guidelines for the transposition of European Commission directives based on the New Approach and the Global Approach. The CE marking does not apply to products that are to be exported outside of the EC.

9 Glossary

CE mark
Certifies the conformity of a product with the essential requirements of the directives and confirms that the product has undergone all the relevant assessment procedures in line with Community legislation.

CEN/CENELEC
CEN and CENELEC are associations governed by Belgian law. Their members are the national standards bodies of EU and EFTA member states. These two associations develop "regular" European standards (EN), many of which come about as a result of consensus between the parties involved and have to be transposed into national standards.

Certification body
An organisation which has received Accreditation to perform certification on other organisations as an impartial third party.

Commission of the EU
The European Commission has the right to submit legal texts to the Parliament of the EU and the Council for acceptance. It is responsible for implementing European directives, regulations and decisions and also supervises compliance with these provisions. In addition to this, the Commission represents the interests of the Union at international level.

Conformity
Conformity signals agreement with the applicable directives or with health and safety requirements from these directives as well as with the necessary legal provisions for drawing up the declaration of conformity and affixing the CE mark.

Conformity assessment/Conformity testing
Systematic assessment of the extent to which a product, process or service fulfils the prescribed requirements

Declaration of conformity
The declaration of conformity is...
1. a procedure in which the manufacturer or his authorised representative established in the Community declares that the machinery placed on the market complies with all the relevant safety requirements of the appropriate directive.
2. a form that is to be supplied with every machine and must be drawn up in the user's language.

Directives
Made by the European Parliament, the Council, and the Commission "a directive shall be binding, as to the result to be achieved, upon each Member State to which it is addressed, but shall leave to the national authorities the choice of form and methods." (Article 249 (ex Article 189) of the EC Treaty)

Directive on Electromagnetic Compatibility
The Directive on Electromagnetic Compatibility applies to all apparatus that may cause electromagnetic disturbance. Examples include private radio and television receivers, medical and scientific apparatus and instruments, domestic appliances.

EC declaration of conformity
By outlining an EC declaration of conformity, manufacturers officially state that the machinery they have put on the market complies with the fundamental requirements of Annex I of the Machinery Directive. If other EC directives have to be applied to the machinery, the declaration of conformity is used by manufacturers to announce and confirm that the machinery they have put on the market also complies with the fundamental requirements of the other directives.

EEC Treaty
Treaty establishing the European Economic Community (EEC Treaty): includes e.g. Article 100a: directives for the approximation of legislation in the Common Market; Article 118a: rules on the creation of minimum regulations for improving the working environment.

Electromagnetic compatibility directive - EMCT
This directive, usually referred to as the "EMC Directive", is part of "Council Directive 89/336/EEC of 3 May 1989 on the approximation of the laws of the Member States relating to electromagnetic compatibility". Since 1 May 1989, this directive has been amended by directives 91/263/EEC, 92/31/EEC and 93/68/EEC.

Essential requirements
Requirements that represent the core of European Union law around which an effective policy has been developed in matters of safety, health and other measures for those areas covered by the "New-Approach directives".
ETSI The European Telecommunications Standards Institute (ETSI) was founded by the EU Commission in 1988 as the successor organisation to the Conférence Européenne des Administrations des Postes et des Telecommunications (CEPT - European Conference of Postal and Telecommunications Administrations).

European Community
The European Community was established by the Treaty establishing the European Economic Community on 25 March 1957 in Rome. It was aimed at the "harmonious development of economic activities", a "continuous and balanced expansion" and "increased stability". To this end a common (or single) market was to be created. The EC constitutes the most important pillar of the EU.

European Union
The European Union is a family of European countries with similar basic values, political systems and common goals. It provides a framework for economic and political co-operation. Its 25 member states transferred substantial elements of national sovereignty to the EU. Main goals of the EU are prosperity, freedom and the creation of a European identity.

European Commission (EC)
The European Commission (formally the Commission of the European Communities) is the executive of the European Union. Alongside the European Parliament and the Council of the European Union, it is one of the three main institutions governing the Union. Its primary roles are to propose and enact legislation, and to act as 'guardian of the treaties' which provide the legal basis for the EU. The role of the European Commission has many parallels with the executive body of a national government, but also differences.

EU Machinery Directive
This is the Council Directive of 14 June 1989 on the approximation of the laws of the member states relating to machinery (89/392/EEC). It has been amended by several Council Directives, currently (98/37/EC) and has been implemented in Germany as part of the Geräte- und Produktsicherheitsgesetz (Equipment and Product Safety Act).

European standards
Standard adopted by CEN/CENELEC and carrying with it an obligation of implementation as an identical national standard and withdrawal of conflicting national standards

Generally acknowledged good engineering practice
Generally acknowledged good engineering practice covers written or verbal detailed descriptions of processes, appliances and operating methods which are believed, according to prevailing opinion, to be appropriate for achieving the legally prescribed objective. This practice is proven or will be proven to be viable. Economic aspects must be considered in any legal considerations for appropriately set objectives.

Global Approach
If a certain product does not meet the minimum health and environmental protection standards of an EU member state but at the same time has been proven to be needed, an exception is made in order to unify the European system of certification and accreditation and to avoid the various tests that a product might have to undergo at national level

Harmonised directives
These directives, provided they have been issued in accordance with the New Approach, correspond to the standardisation requests filed with the European standards institutions, which deal with the detailed problems during their standardisation work

Harmonised standards
Standards which have been drawn up by CEN or CENELEC on the instructions of the EU and on the basis of directives, and which are to be implemented nationally. They guarantee the interchangeability of products, processes and services or the mutual comprehensibility of test results or information which is presented in accordance with these standards.

Hazard
The ability to cause damage.

Hazard analysis
The hazard analysis specifies which hazards can be generated by machinery and how they can be eliminated by design measures. more

IEC
The International Electrotechnical Commission (IEC) was founded in London in 1906 with the involvement of the Association for Electrical, Electronic and Information Technologies (VDE) following a resolution by the national delegates at the International Electrotechnical Congress held in St. Louis/USA in 1904. Since its foundation the IEC has been concerned with the development of international electrical standards.

Instruction handbook
It should describe everything that the user needs to know about operating the machinery in a safe manner. It also should include warning notes on the intended use as well as foreseen misuse. The instructions should be described precisely and clearly and include the necessary cautions regarding handling and use of the product (transport, storage, commissioning, use, maintenance, inspection, cleaning, repair, disposal, etc). Honest means clear and comprehensive information on the possible hazard and the residual risk.

Internal market
The internal market is an economic area without internal restrictions in which the four fundamental freedoms can be realised, that is, the free movement of goods, persons, services and capital.

ISO
The "International Organization for Standardization" (ISO) is a worldwide association comprising the national standards bodies from more than 130 countries. ISO is a non-governmental organisation that was founded in 1947. The aim of ISO is to promote the development of uniform standardisation so as to achieve a situation in which goods and services can be exchanged freely on an international level.

Low Voltage Directive
Electrical equipment may be placed on the market only if, having been constructed in accordance with good engineering practice in force in the Community, it does not endanger the safety of persons, domestic animals or property when properly installed and maintained and used in applications for which it was made. To this end, the 11 safety objectives referred to in Annex I of this directive must be fulfilled.

Machine
For the purpose of the EU Machinery Directive, a machine is an assembly of linked parts or components, at least one of which moves, with the appropriate actuators, control and power circuits, etc.

Machinery directive
Machinery directive prescribes fundamental health and safety requirements that all machines brought into circulation within the EU have to satisfy. A machine as defined by this directive is "...linked parts or components, at least one of which moves, ... joined together for a specific application, in particular for the processing, treatment, moving or packaging of a material." Individual components which perform a safety function are treated separately in this directive

Manufacturer's declaration
By drawing up the manufacturer's declaration, manufacturers confirm that the product concerned is intended exclusively to be combined with other machinery to produce an "entire machine" or "assembly of machines" and must not be operated independently of these. The manufacturer's declaration must be drawn up for all "machinery that cannot function independently". Naturally, such "machinery that cannot function independently" must in itself meet the terms of the essential requirements of the Machinery Directive and all other applicable EC directives.

Minimum quality standards or safety standards
These standards are developed to specify acceptable product or service performance along one or more dimensions such as functional levels, performance variation, service lifetime, efficiency, safety, and environmental impact (Tassey, 2000, p.4)

Mirror Committee
Represents European Technical Committees on a national level.

Modular Approach
In December 1990, on the basis of this Glo-bal Approach for certification and testing, the Council of the European Union created the so-called "Modular Approach" of conformity assessment (see the CE conformity marking modified by the Council Resolution of 22 July 1993, cf. Official Journal L220 of 30 August 1993). It is implied in the "Modular Approach" that the manufacturer should be offered alternative options within Community law for demonstrating compliance with the EU technical harmonisation directives. In this approach, eight different modules, prescribing measures of varying expense and input of effort for quality assurance, testing and certification, are described.

Module A
Internal Production Control (declaration by manufacturer) Module A is the simplest procedure for conformity assessment. It is suitable for products with low safety requirements. This is the only module that can manage without the involvement of a notified body. In this instance the manufacturer bears the responsibility for declaring that his product fulfils the requirements of the EC Directive that affects his product. Submitting the declaration of conformity is therefore referred to as submission of the manufacturer's self certification. Following this, the CE Mark can be affixed to the product.

Module B
EC Type-Examination ("Third-party certification") The Notified Body examines the product (type) and if the product fulfils the regulations, certifies conformity from the corresponding directive. This module can only be used in conjunction with Modules C, D, E or F.

Module C
Product Quality Assurance (conformity to type) - Module C is only used in conjunction with module B. The manufacturer certifies that all the products he manufactures meet the type tested, cf. module B, in all aspects.
Product Quality Assurance
The declaration of conformity may be drawn up and the CE Mark affixed.

Module D
This module is geared towards defect-free production. Product quality is assured by monitoring the production process. The manufacturer certifies that all the products he manufactures meet the type tested, cf. module B, in all aspects. He produces this product while constantly operating a quality management system, such as that specified in DIN ISO 9002, for example. Then the declaration of conformity may be drawn up and the CE Mark affixed.

Module E
Product Quality Assurance
The manufacturer certifies that all the products he manufactures meet the type tested, cf. module B, in all aspects. He produces this product while constantly operating a quality management system for inspection and testing , such as that specified in DIN ISO 9003, for example. Then the declaration of conformity may be drawn up and the CE Mark affixed.

Module F
Product Verification
The method according to Module F stipulates testing of each individual product or at least statistical control by a Notified Body. Consequently, Module F has to be used in the case of relatively high safety requirements or for special machinery. The manufacturer certifies that all the products he manufactures meet the type tested, cf. module B, in all aspects. For this purpose the Notified Body verifies conformity with the type during production. Then the declaration of conformity may be drawn up and the CE Mark affixed.

Module G
EC Unit Verification The method according to Module G expressly lays down the inspection of each individual product. It is therefore intended for special products with very high safety requirements.

Module H
Full Quality Assurance The method according to Module H is the most costly and involved certification procedure. It requires a certified QM system according to DIN EN ISO 9001, not only for the design and manufacture of the products but also for inspection and testing.

Mutual recognition
Concept introduced by the European Court of Justice in its Cassis de Dijon ruling of 1979. Basically, "any product lawfully produced and marketed in one Member State must, in principle, be admitted to the market of any other Member State." By importing such goods without imposing any barriers Member States therefore mutually recognise the underlying technical rules of their respective counterparts. Obstacles to the movement of goods are only justified should issues of safety, health environment and consumer protection be at stake.

National standards
Document, established by consensus and approved by a recognised national body, that provides for common and repeated use, rules and guidelines or characteristics for activities or their results, aimed at the achievement of the optimum degree of order in a given context."

New Approach
New Approach (07 May 1985): EC directives only specify the essential health and safety requirements; European standards define the requirements at a high level of protection; affected groups are to be involved in drawing up standards; provision is to be made for safeguard clause procedures.

Notification
Notification is a term that means announcement (in the sense of making something known) and informing. So that not simply "any old" certification body can declare the conformity of products with the appropriate directives, the Member States have to inform the European Commission in Brussels of competent organizations (notification). The nomination of these national bodies remains a matter for the individual Member States. Therefore, before the Member State notifies the European Commission of the testing and certification bodies, it is also necessary for it to be convinced of the organisation's competence. This it can do with the aid of the minimum criteria laid down in the EN 45000 series of European standards.

Notified body
Also called independent third body or impartial third body. The body must be recognised by an authorised organisation of an EC member state as well as the EC Commission and the other member states and also be nominated by the member state concerned.

Official journal of the European Commission
An official publication of the Institutions of the European Union which is published daily. (CEN/BOSS Glossary: www.cenorm.be/BOSS/glossary.asp#N)

Old Approach
Stands for full harmonisation of any general or detailed condition a product shall meet by legislative means.

Quality mark
A quality mark certifies quite generally that the quality of a product has been tested and supervised. Anyone wanting to use a mark of quality must join an association for marks of quality or make a special binding declaration to adhere to the association's charter, in Germany. Under the rules of the associations, the members are duty-bound to observe the conditions of quality and testing as well as the special terms relating to the award and use of the mark of quality. It

is effective in terms of its advertising impact and withdrawal of the permission to use it generally brings noticeable losses of income.

Regulated area
A regulated area is the opposite of an unregulated area. If a certain product comes from a regulated area, a certain conformity testing procedure produces the conditions to allow it enter the free circulation of goods

Risk analysis
The use of available information with the aim of identifying hazardous occurrences in advance and estimating the risk.

Risk assessment
A procedure based on the risk analysis and which, by considering factors such as social or economic aspects, determines whether a risk is tolerable.

Risk evaluation
A comprehensive evaluation of the probability and the degree of the possible injury or damage to health in a hazardous situation in order to select appropriate safety measures.

Standard
Standards can be de facto, which means they are followed for convenience, or de jure, which means they are used because of (more or less) legally binding contracts and documents.

Standstill period
Under the so-called New Approach, the Commission gives a mandate to the European standards bodies to prepare a standard. There is a "standstill period" that should be observed, by the national standards bodies, during which a European standard (EN) is developed by CEN.

State of science and technology
The state of science and technology is the stage in the development of advanced processes, appliances and operating methods, based on the latest science and technology, that has been proven to be capable of safely achieving the legally prescribed objectives. Economic aspects do not play any role in legal considerations, since, in the field of health and safety, hazard prevention is more important than economic aspects.

State of the art
State of the art is the development stage of advanced processes, appliances and operating methods. It is peer reviewed by the leading experts in the respective field to be suitable to achieve the legally prescribed objectives. The economic aspects are only secondary when considering the appropriateness of

the set objectives. The method or one of the equivalent statuses must have proven its practical value or should have been successful in practice.

Technical Committee
Technical Committees on the European level are represented by members of national European standards organisations

Technical documentation
Technical documentation is an essential prerequisite for affixing the CE mark and is divided into two sections:
- Internal technical documentation
- External technical documentation (instruction handbook).

Third-party certification
Third-party certification means certification of compliance with the essential requirements of the directives performed by an outside independent body.

Three-tier principles
The manufacturer should apply certain principles when choosing the appropriate method of hazard elimination; these are known as "three-tier principles":
1 Hazard removal or minimisation (incorporating the safeguarding measures into the development process by modifying the design)
2 Installation of the required safeguarding measures to counter the non-removable hazards listed under item 1.
3 Information to the user on all residual hazards (special safety instructions) caused by the ineffectiveness of the safeguarding measures mentioned under item 2 and information on any special training and necessary protective equipment that may be required by the operator.

Treaty of Rome
The Treaty establishing the European Economic Community was signed on 25 March 1957 by the six founding members and came into force on 1 January 1958. It aimed in the first place at the creation of a Common Market, i.e. the free movement of persons, goods, services and capital, and introduced a common agricultural policy and a common transport policy. The Treaty of Rome has been modified various times by all subsequent EU treaties.

Type A standards
These are standards that create basic statements on the safety of machinery and only have to be laid down once in a "basic standard". These also deal with basic concepts and principles for design, operating instructions, forms of expression, etc.

Type B standards
These are standards accompanied by safety-related issues that not only apply or are limited to one single machine or one single application, but can apply in a similar or equal manner to machines or applications and may be considered "group standards".

Type C standards
These refer to "machine" or "product standards" where characteristic safety conditions are laid down or defined for groups of machines or individual machines.

Unregulated area
An unregulated area is covered by the principle, that the member states of the EU know each other

10 Key questions

- What are the essential features of the New and Old Approach?
- Which directives are particularly important in respect of the CE mark in the area of mechanical engineering?
- What are the steps involved in CE marking?
- What are harmonised standards? And are they legally binding?
- Which conformity assessment procedures are you familiar with?
- What manufacturer declarations are you familiar with?
- What are the essential contents in the declaration of conformity?
- What are the essential contents in the manufacturer's declaration?
- What are the consequences if the CE mark is abused by the manufacturer?
- What other marks do you know?
- What are A, B and C standards?
- If the relevant standards are applied to a product, does this imply compliance with criteria for the CE mark?

Henk de Vries · Albert Feilzer · Harry Gundlach[1] · Jan Simons[2]

Abstract

This lecture deals with the relations between standardization and conformity assessment. It explains the different roles of first, second and third parties in conformity assessment and the application of conformity assessment on products, services, processes, management systems and people. The following sections look at conformity assessment by independent third parties, certification, and to the recognition of certification organizations in the form of accreditation. A later section then presents the international business context, including standards, notification by governments, mutual recognition of certification and accreditation, and the role of the World Trade Organization.

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1 Introduction

Even before the beginning of our era, the Chinese applied a simple form of certification. In their pot bakeries each pot was inspected by an inspector before it was baked in a furnace. When the pot met the requirements, the inspector provided it with an impression of his thumb, using a fingerprint as a mark. Instead of thumb prints, marks can be printed on products.
In the above example, the function of the mark is to visualize the compliance of a product with certain predefined quality requirements: minimum requirements that have to be met by the product. Standards are often used for proving that requirements are met: standards that set the requirements and/or standards that provide methods for testing.

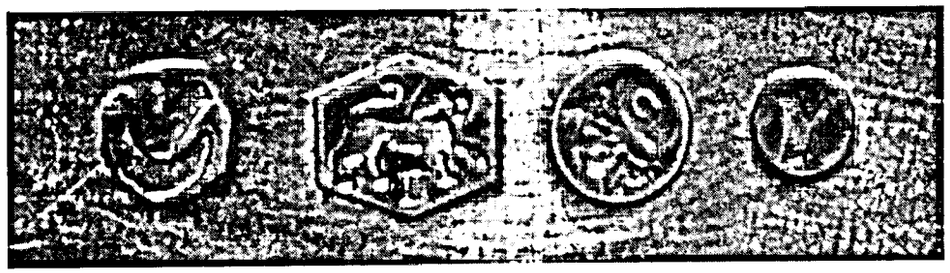


Figure: Marks on a silver beaker, placed by the manufacturer to demonstrate its authenticity. (© Albert Feilzer)

Historically, many nations had, for varying reasons, developed their own regulations for the import of goods and products, for instance to maintain public health by preventing the import of diseases or to protect national industries. Nowadays these regulations are frequently perceived as technical barriers to trade (TBTs). The World Trade Organization (WTO) aims to remove these TBTs while, at the same time, maintaining measures to prevent adverse consequences of free trade with regard to health and safety and sometimes environmental effects. In general, industry shares this aim and prefers 'one standard, one test, accepted everywhere' (ISO, 2002). For that reason, a comprehensive international system for standardization and conformity assessment has been developed.

Example: Medical devices
Medical devices such as artificial heart valves are items that are exported all over the world. As these items should be packed in a sterile condition, it is of importance to have common agreement regarding the requirements of a sterile condition. A sterile medical device is a medical device that must be free from live bacteria or other micro-organisms and their spores. National or regional

standards and regulations often define the sterility requirements that sterile medical devices must meet. The European Union and the USA apply different definitions and different approaches for a sterile condition. As a consequence, manufacturers of medical devices that need to be sold in a sterile condition are subject to two different test systems and need two different certificates if they wish to be able to sell their product both in the European Union and in the USA. One can see this as an unnecessary barrier to trade leading to inefficient testing procedures and therefore to unnecessary costs.

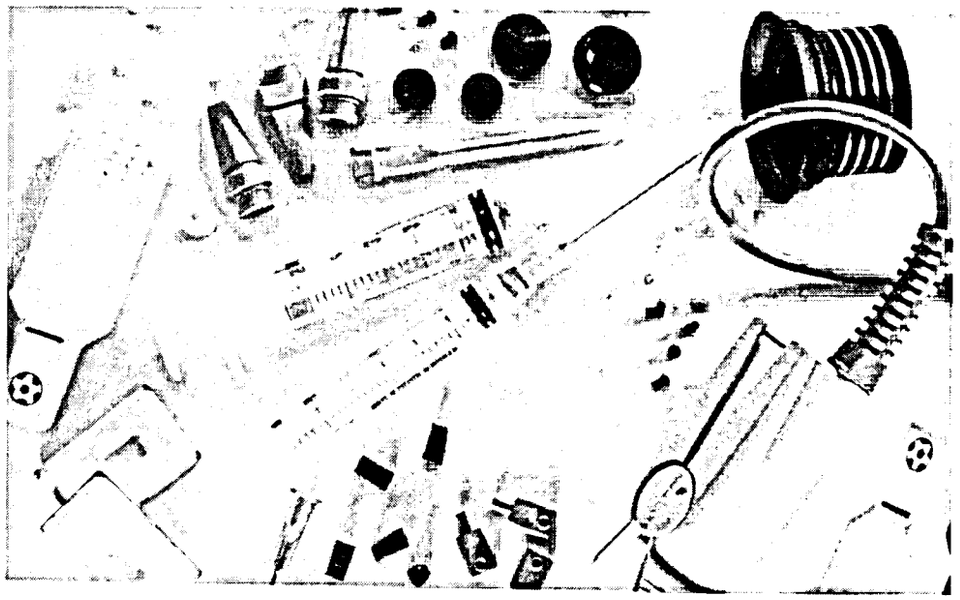


Figure: Medical devices (Source: www.standards.org)

1.1 Relevant parties in conformity assessment

In conformity assessment the following parties can be distinguished:

- a 'first party': the organization that wants to have a product, service, process, person or management system to be tested or assessed;
- a 'second party': the consumer/purchaser of the organization's product or service;
- a 'third party': a party independent of both 'first' and 'second' parties that may test/assess the product, service, process, person or management system, this party can be a certification body;
- the 'accreditation body': a party who supervises the impartiality and competence of the certification body, see Section 4.

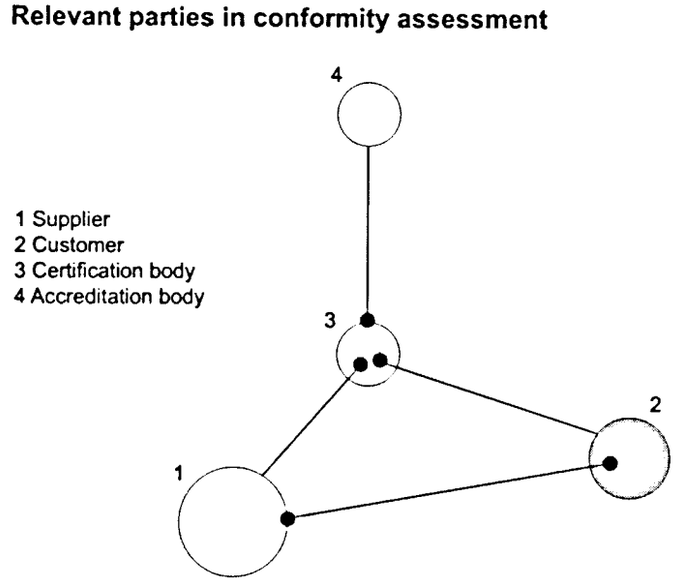


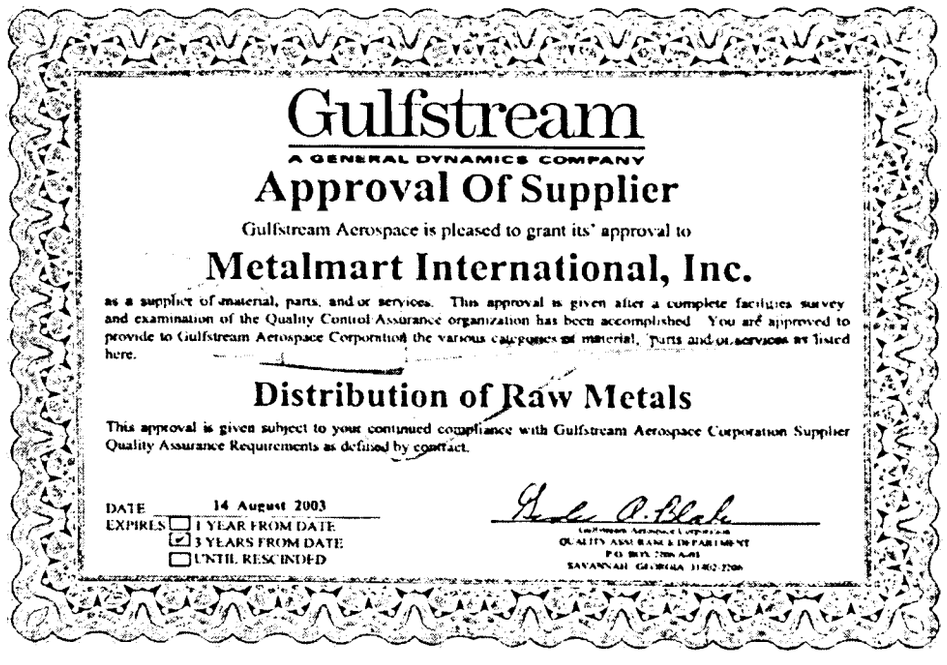
Figure: Relevant parties in conformity assessment (© de Vries)

1.2 First-party conformity assessment

A (first) party can assess itself, its own product, a service, a management system or other entities and declare that it/they meet/s certain requirements (Self Declaration of Conformity - SDoC also sometimes called Suppliers Declaration of Conformity or Manufacturer's Declaration). This does not necessarily mean that such recognition has no meaning. On the contrary, the company explains that it complies with certain standards and therefore is liable for this claim. This is also covered by liability legislation, which stipulates that the manufacturer is responsible. In general, and especially in the United States, suppliers have to be very careful because of claims by customers in relation to product liability laws (Beerepoot-Sangen and Leentvaar-Leistra, 1991). A supermarket's generic brand can be seen as a form of SDoC, though the requirements as such are not known to the consumer. The international standard ISO/IEC 17050:2004 provides guidance for SDoCs.

1.3 Second-party conformity assessment

When an organization wants to know if its suppliers meet its quality requirements, it can decide to check the products and/or the quality management systems of its suppliers before buying the latter's products. In this case they may prefer to carry out tests and control 'audits' themselves rather than leave this to an anonymous third party, a certification body.
A supplier may use this 'external audit' by an important or well-known customer to convince other customers. However, second-party conformity assessment can have some disadvantages. It might be expensive for the 'second party' while it may be unpleasant for the 'first party' if several external customers want to assess their processes or management system (then the supplier very often has several auditors present, even at the same time).
Many large companies, such as the automotive company Ford, do review their subcontractors. The recognition as 'approved supplier' of Ford gives them status, which may influence other customers in such a way that they decide not to carry out audits or demand certification institutions to carry out such audits on the 'approved supplier'.



Gulfstream
A GENERAL DYNAMICS COMPANY

Approval Of Supplier

Gulfstream Aerospace is pleased to grant its' approval to

Metalmart International, Inc.

as a supplier of material, parts, and/or services. This approval is given after a complete facilities survey and examination of the Quality Control Assurance organization has been accomplished. You are approved to provide to Gulfstream Aerospace Corporation the various categories of material, parts and/or services as listed here.

Distribution of Raw Metals

This approval is given subject to your continued compliance with Gulfstream Aerospace Corporation Supplier Quality Assurance Requirements as defined by contract.

DATE 14 August 2003
EXPIRES ☐ 1 YEAR FROM DATE
☑ 3 YEARS FROM DATE
☐ UNTIL RESCINDED

Figure: Second party conformity assessment - Example (Source: www.metal-mart.com)

1.4 Third-party conformity assessment

Modern certification is a procedure by which a 'third party', certification body or registrar, gives written assurance that a product, process, service or management system conforms to specific requirements. It is a third-party issue of a statement, based on a decision following review, that fulfilment of specified requirements has been demonstrated. As a visible sign, the supplier receives a certificate indicating that adequate confidence is provided that the relevant product, process service or management system is in conformity with a specific standard or other normative document. The certificate gives no 100% guarantee that these requirements are met, but it certainly gives a serious level of confidence that they are met. Certification also fulfils the role of information carrier (De Graaff, 1996).

2 Objects of conformity assessment

Objects of conformity assessment can be:

- products
- services,
- processes,
- management systems, and
- personnel.

These will be addressed in the subsequent subsections.

2.1 Products

Suppliers can use several ways to indicate certain characteristics of their products, including:

- pictograms - often used to give advice to users, e.g. how to wash cloths;
- logos and trade marks with a certain image related to it, e.g. Coca Cola, Nike, Rolex.
- Self-declaration of conformity providing statements about, for instance, the product's quality.
- marks of conformity issued by third parties, e.g., NF (France), SNI (Indonesia).

The latter is product certification, which is primarily a commercial instrument for enterprises: the choice of mark on the product can stimulate its market acceptance. Due to the expenses of testing and certification the choice of whether to certify a product or not is a commercial decision. From a commercial viewpoint, a product certificate does not necessarily mean much. In many cases, it only increases the options when making an offer. Whether this leads to a real order is dependent on, amongst other factors, the price, the delivery time and the quality perception (what the supplier offers and/or what surpasses what is expected, for example delivery to special locations, gift packaging, spread of payment, etc.). The latter factors enable an organization to distinguish itself from competitors. For reputable companies, the added value of a certificate is less important than for relatively unknown companies, who need it as a 'flag to wave'. As a consequence, the added value of a certificate on a well-known product is less than for an unknown product which can benefit from the "backup support" usefully provided by a certificate for entering the market.

Some products, e.g. medical devices such as artificial heart valves, are subject to specific laws, like the European 'New Approach' Directive on Medical Devices, resulting in de facto mandatory certification.

Example: UL mark

Product certification can relate to quality aspects, but also to safety aspects, environmental issues or to fair production circumstances. An example is the UL mark issued by the American Underwriters Laboratories Inc. The UL Mark on a product means that UL has tested and evaluated representative samples of that product and has determined that they meet UL's requirements. Under a variety of their programmes, products are periodically checked by UL at the manufacturing facility to make sure they continue to meet UL requirements. These requirements are in fact the basic attributes to ensure safety and/or performance of the products.

UL Mark



Figure: UL Mark (Source: www.ulstandardsinfonet.ul.com)

Example: Keymark

The European standardization organizations CEN and CENELEC have introduced a European product quality mark, the Keymark. This mark shows whether a product meets all the related voluntary European standards on product performance. It allows customers to differentiate between products and distinguish between quality products based on European standards, third-party testing and a manufacturers' quality system which covers the production line. Therefore, the organization that represents consumer interests in standardization at the European level, ANEC (European Association for the Co-ordination of Consumer Representation in Standardization), supports the Keymark and appreciates the benefits of a European third-party certification mark. The Keymark reduces testing and certification costs and time for manufacturers, which should in principle result in greater choice and lower costs for the consumer. Therefore, the Keymark should contribute to a single European market without barriers to trade.

Manufacturers and certification bodies are less enthusiastic, so far the use of the Keymark is limited but nevertheless it is increasing. The Keymark is used by 24 certification bodies in 15 European countries on the basis of some 145 European standards (data September 2006). More information can be found on the website of CEN: http://www.cenorm.be.

CEN Keymark

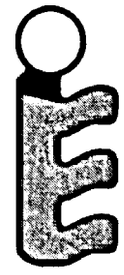


Figure: CEN Keymark (www.key-mark.org)

The Keymark should not be confused with the CE mark. In that case, the supplier declares that the products meets essential requirements, mostly on safety, laid down in New Approach Directives see the Module 'The European Union and its New Approach'. CE marking is a declaration by the manufacturer that the product meets all the appropriate provisions of the relevant legislation implementing European New Approach Directives. Jeymark and CE marking can be seen as complementary to each other and may apply to the same products.

CE Mark

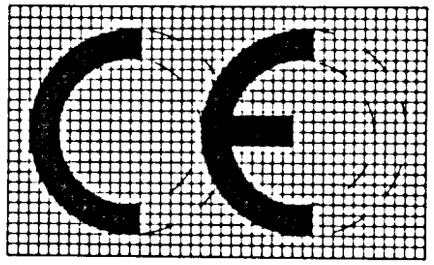


Figure: CE Mark (Source: www.ec.europa.eu)

2.2 Services

In contrast to products, services are often less tangible. Nevertheless, conformity assessment applies here as well. McDonald's, for example, has standardized its services to a large extent and has a system in place to make sure that all over the world their outlets meet the requirements the company has set for its services.
Third-party assessment in the form of certification is growing in service sectors as well, especially in France. For instance, in the area of tourist services, French certification activities include hotels, camping sites, restaurants, tourist offices, renting cars, congresses. Quality areas include information and communication, attitude of personnel, competence of personnel, atmosphere and comfort of places, equipment used, and safety (Barthet, 2005).

2.3 Processes

In many cases, the way a process is executed is of crucial importance for the quality of the product it creates. In painting a car, for instance, not only the colour of the paint but also a dust-free environment is of crucial importance. To enable a reliable and reproducible quality in such a case, an organization may choose to develop a detailed process description which can be used as a benchmark for this and similar production processes. In the case of assessment by an independent third party, process certification may apply. Examples of process certification can be found in the food industry where, for example, hormones or animal living space cannot be detected in the final product (De Graaff, 1995).
Another example of process standardization and related certification concerns the process of developing software, based on the CMM (Capability Maturity Model) standard. This standard was developed by the Software

Engineering Institute, USA, for huge software development projects. The standard distinguishes between five levels of 'maturity'. The ranking is based on the company's standardization of processes in certain subject areas (Humphrey, 1989). Only a few software companies, most of these in India, have managed to obtain a certificate demonstrating that they have achieved the highest CMM levels, 4 and 5.

2.4 Management systems

A management system is a system to establish policy and objectives and to achieve those objectives (ISO 9000:2005). Examples of management systems include quality management systems, occupational health and safety management systems, and environmental management systems. Two other modules address management systems including conformity assessment: namely the case studies on 'Quality Management Methods and ISO 9000 Quality System Certification' and 'Implementation of the ISO 14000 Environmental Management System'. In this module we will just pay some attention to quality management systems.
The best-known standard for management systems is ISO 9001:2000. At the end of 2005, the worldwide total of certificates to the ISO 9001:2000 quality management systems standard was 776 608. Certificates had been issued in 154 countries (ISO, 2006).
The standard ISO 9001 assumes that ultimately the performance of an organization is determined by how the customer perceives it. Customer requirements do form the input for the realization of a product. The output (the product can also be a service) is provided to the customer and should lead to satisfaction for that customer. For this reason, the production process has to be mastered as a primary company process. The control system is the quality management system. Top management plays a central role. By managing resources (which are also taken to mean people: human resources) the management has to ensure that the organization is able to realize products that fulfil the customer requirements and the legal demands. As a consequence, not only the quality of the processes and of the products have to be assessed, but also the satisfaction of the customer. In the case of differences between realized and desired results, corrective actions (for improvement) may be taken. Preventive actions must remove causes of possible errors, to prevent these from occurring again. The difference between desired and realized performances forms the basis for continuous improvement of the quality management system. In this way harmonization between the organization and the requirements and desires of the customer will improve. The supervision of this process (managing) is primarily the responsibility of top management.

A separate standard has been developed for auditing an ISO 9001-based quality management system: ISO 19011 "Guidelines for quality and/or environmental management systems auditing". This standard has been developed in such a way that it can also be used for the audit of environmental management systems based on ISO 14001 (Orecchini and Sabatini, 2003). Organizations can use this standard for their own internal audits (first party) but the standard can also be applied by external parties for the auditing of a supplier's management system: by customers (second parties) or by certification bodies (third parties).

Most often, external reasons cause organizations to have their management system certified: the certificate 'proves' to consumers, governmental organizations and others that the organization is able to systematically manage quality, environment or working conditions. Companies can set up management systems for quality, occupational heath and safety and/or environmental conditions completely in an integrated or partly separated form. The audits of these systems in terms of effectiveness and meeting the requirements of the standards can be carried out separately for each separate system or for the integrated system.

A number of large companies also only want certified suppliers. For example, in many cases the British government requires an ISO 9001 certificate in cases of public procurement/tenders. A number of business associations require a certificate as a condition for membership.

Besides ISO 9001, other more specific standards are also being developed with requirements for the management systems of certain more specifically defined businesses. Examples are ISO 13485:2003 for the medical device industry and ISO/TS 16949:2002 for the automotive sector.

Over the course of time, a shift from external to internal aims for certification can be observed in some organizations (De Vries, De Jong and Wentink, 2002). Internal reasons for management system certification include:

- The certificate may be considered as the crown on the performed efforts. It can function as a milestone for all employees to work towards. However, this can be seen as a danger too when gaining the certificate becomes an aim in itself, whereas it is only a tool for achieving other aims.
- The critical view of an outsider (the auditor of the certification institution) can reveal errors in the system. This may be annoying, but it offers a means of improving the system.
- The certificate 'proves' to top management that the company meets certain requirements.
- Because the certificate is regularly checked, the organization is forced to maintain the system well. Slackened attention to quality, environment and/or working conditions can lead to the withdrawal of the certificate. This is a reason to remain alert.
- Thanks to a certificate fewer or no audits are required by customers or other parties.

2.5 People

The rapid advances in technological innovation and the growing specialization of personnel have led to the development of certification schemes for professional human activities. Certification of personnel has become important as a means of demonstrating professional ability. This is increasingly significant in the light of today's difficult global job market, where a job is no longer considered a 'job for life'.

Certification of persons provides a relatively simple means by which job capability, for 'pilot' or 'welder' for instance, can be assessed and recognized (Irving, 2001). The certification scheme defines the profile of education, knowledge, experience and responsibility required for a specific job, and provides a professional assessment procedure. Certification is concerned with current competence rather than considering the historical attainment of a diploma as the dominant feature, because periodic renewal is required. At present, more and more people have to demonstrate an appropriate level of competence in knowledge and its application. To employ competent personnel, manufacturers should ensure that candidates such as engineers, designers and technicians have demonstrated the required and relevant level of competence. This is increasingly becoming a contractual requirement, e.g.:

- The European Directives and standards for welding require people with welding or welding related responsibilities to be able to demonstrate that they are competent to carry out these responsibilities
  (EN 719 'Welding Coordination - Tasks and Responsibilities') (Irving, 2001).
- Malaysia developed a certification scheme for quality system consultants (Aziz Mat, 1998).
- In the USA, a system of (compulsory) certification for food safety managers is in place (Almanza and Nesmith, 2004).

Example: Medical professionals

Certification of persons, from the perspective of their professional quality, is also used in the medical discipline. For a long time, the medical academic degree was seen as a certificate of competence for the medical profession. With the increasing speed of technological development, the academic degree is no longer a lifelong guarantee of competence. As a result, there is an international trend towards enforcing members of the medical profession to periodically undergo a re-registration process. In this way the medical doctor has to prove that his/her medical knowledge is up to date. In this way, society is creating a form of quality assurance with regard to health care.

2.6 Mixtures of objects

In many cases, conformity does not just concern products, services, processes, persons or management systems but rather a mixture of these. In the McDonald's case, for instance, not only the services are standardized, but the (food) products as well, many processes have to meet certain criteria (e.g., for food safety), the company has rules for the employees, and McDonald's operates a management system which combines quality as well as environmental and food safety issues.
More generally, food safety is an area where a hybrid set of conformity assessment objects can be observed. The final aim concerns products: these should be safe. However, the safety of the products depends on the processes of preparing them. For these processes a Hazard Analysis Critical Control Point (HACCP) system can be used. An HACCP system requires an assessment of food hazards, the establishment of acceptability limits, the monitoring of processes and the implementation, where necessary, of corrective action. Documentation and verification are also key elements of an HACCP approach. Certification may also include the qualification of food safety managers (Almanza and Nesmith, 2004). For organizations involved in food production, management system certification may be feasible as well (Mahler et al., 2005). In fact, the integrity of the entire food supply chain should be ensured, for which the management system standard ISO 22000 is available (Færgemand and Jespersen, 2004).

3 Certification - voluntary or mandatory

Certification is primarily a voluntary instrument for all market parties. Nevertheless, in some cases voluntary certification is 'de facto' mandatory. Large buyers may require marking on the products they buy. In the building community, in particular, it is common practice for local authorities to demand in their public tenders for large house construction projects, for instance, that there should be local - safety - marks on materials such as sewerage pipes or bricks. This 'de facto' mandatory certification also exists for services, for instance, when an electrician has to be certified in order to get permission from the local electricity company to connect an electrical installation to the mains supply. We have already seen the necessity of 'voluntary' ISO 9000 certification for participation in some public tender projects. These local and/ or national practices can function as technical barriers to trade for foreign companies. The EU is attempting to terminate the different product requirements for each country. 'De facto' mandatory (voluntary) certification is conceived as a customer's wish; it is free for the entrepreneur to make use of it.

The choice is a consequence of his commercial policy. The business community prefers as little as possible 'mandatory' certification. In their perception, certification should only be mandatory where major (safety) risks prevail.

4 Accreditation

4.1 Introduction

Accreditation is the procedure by which an authoritative party gives formal recognition that a certification body is competent to carry out specific certification tasks. In terms of the standard ISO/IEC 17000:2004; accreditation is third-party attestation related to a conformity assessment body conveying formal demonstration of its competence to carry out specific conformity assessment tasks. The term accreditation originates from the Latin word accredo = meaning to give credit or acknowledgment (authorization), official substantiation. In accreditation an authorized body investigates and declares that a conformity assessment body, e.g. a test laboratory, is competent to conducts its conformity assessment activities, e.g. tests, in accordance with certain standards.

Accreditation concerns different categories of conformity assessment bodies, both private and, as is the case in Europe for example, public:
- Certification bodies
- Inspection bodies
- Testing laboratories
- Calibration laboratories
- Proficiency testing

Accreditation is based on internationally accepted standards, both for the conformity assessment bodies and their activities (see Section 5) and for the accreditation body and its activities: ISO/IEC 17011:2004. In general, there is one accreditation organization per country. Mostly it is a governmental organization, exceptions include The Netherlands and the UK where the accreditation body is a private organization with close ties to the government. Accreditation of conformity assessment bodies in other countries than the home country is allowed. An accreditation body is an essential element of a national infrastructure for conformity assessment (Donaldson and Leferink, 1998).

4.2 International Accreditation Forum (IAF)

Most if not all accreditation bodies are current members of the International Accreditation Forum (IAF, Inc.). IAF is the world association of Conformity Assessment Accreditation Bodies and other bodies interested in conformity assessment in the fields of management systems, products, services, personnel and other similar programmes of conformity assessment. Its primary function is to develop a single worldwide programme of conformity assessment which reduces risks for businesses and their customers by assuring them that accredited certificates may be relied upon.
IAF promotes the worldwide acceptance, without exception, of certificates of conformity issued by accredited conformity assessment bodies. IAF brings together on a worldwide basis partner accreditation bodies and representatives of stakeholder groups that seek to facilitate global trade through the acceptance of accredited certificates of conformity. Accreditation bodies, having passed peer review visits successfully, become members of the multilateral agreement (MLA) of the IAF.

Logo of IAF

Figure: Logo of IAF (Source: www.iaf.nu)

4.3 Accreditation process

To enable adequate accreditation, the accreditation institutes must not only have knowledge of testing and certification in general, but must also understand the specific, often very technical, aspects of the various kinds of certification and testing houses. It will rarely be possible to have all this knowledge in house. Therefore, external experts are frequently added to the institute's own experts. In practice, in the accreditation of certification bodies more attention is often paid to the structure and the procedures of the accredited organization, than to its technical expertise, while the accreditation of laboratories and inspection bodies focuses especially on their technical expertise.

The normal activities of accredition bodies are (the same holds for certification bodies):
1 Observing/verifying,
2 Judging,
3 Deciding,
4 Reporting.
The accreditation process is carried out using strict procedures. Taking the example of the accreditation of a test laboratory, the main steps are:

1. Registration
The laboratory's organization fills in a questionnaire from the Accreditation Body. The questions concern the laboratory, the organization, the employees, the equipment, the scope and the quality management system. The quality handbook ("manual", in which the quality management system is described) should be submitted some time before the visit.
On the basis of this information, the Accreditation Body decides whether the next step can be made: an orienting examination.

2. Orienting examination
An expert from (or acting on behalf of) the Accreditation Body studies the handbook and conducts an on-site examination. He decides when the actual assessment will take place, how much time is needed, and which experts will be necessary. In the European case, the Accreditation Body will also assess in accordance with harmonized EU criteria, in addition to the requirements of ISO/IEC 17025.

Accreditation procedure for a test laboratory

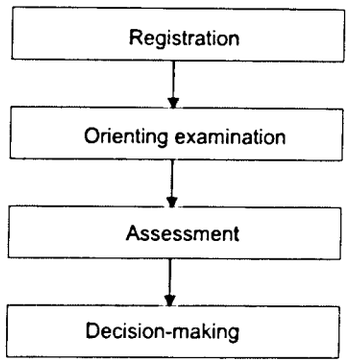


Figure: Accreditation procedure for a test laboratory.(© de Vries)

3. Assessment
The laboratory processes are described in the quality handbook. During the assessment the auditors check whether actual practice matches the description. The goal is that the laboratory work should have a trustworthy and credible outcome. For this reason, the activities have to be well-organized and correctly applied. The leader of the assessment team is usually the same person that has also conducted the orienting investigation. His main attention is devoted to the organizational affairs, while one or more experts are responsible for the assessment of the laboratory activities and research. They look at safety, calibration of equipment, presence of good instructions/procedures (such as measuring records), expertise, and good reporting quality of research results. Where there is a lack of in-house expertise, the hired-in experts should not be linked to the client's competitors.

4. Decision-making
On the basis of the results of the assessment, the Accreditation Body will decide whether or not the organization should be accredited. There are three possibilities:

- The (quality) management system is so bad that accreditation is not awarded. In such cases the assessment can be stopped at an early stage. This will rarely happen because this situation will in most cases become apparent during the orientation talks.
- The laboratory works well, but does not yet satisfy all requirements. In this case, the laboratory can be asked to resolve the nonconformities detected within a particular period.
- The accreditation body grants the accreditation certificate. The certificate indicates the parts of the laboratory for which accreditation has been issued and to which it applies.

4.4 Reasons for accreditation

Reasons for test laboratories to obtain accreditation include:

1. Competitive position
An accredited laboratory distinguishes itself from laboratories that are not accredited. Buyers may gain more confidence in the quality of the laboratory. This enhances the laboratory's possibilities of gaining orders from clients in foreign countries.

2. Minimizing product liability problems
Companies that want their products tested by a laboratory need to know whether the test organization is trustworthy to ensure their liability position. Using an accredited laboratory may help them to be sure of this aspect.

Laboratories can anticipate this market wish through accreditation.

3. Quality guarantee, credibility
The quality of the analyses should be indisputable.

4. Requirements imposed by authorities
In many cases, products have to comply with legislation. Sometimes the manufacturer has to demonstrate the fulfilment of requirements by having its products tested by a recognized laboratory (Notified Body, see Section 6). The national authority assigns laboratories that are competent and trustworthy to execute this conformity assessment. In order to achieve this, the authority may require accreditation as a condition for performing these activities. Hence, laboratories without accreditation are not acknowledged.

5 Standards for conformity assessment

Actually nearly all standards for products, services, processes, persons or management systems can be used to test these products, services, etc. in order to assess conformity with preset requirements. Besides these product standards, ISO and IEC have developed many standards that may help to set up a proper conformity assessment system. The website of ISO (http://www.iso.org) provides an overview of international standards and guides for conformity assessment. We will mention only a few of these and refer for further details to the website.
The standard ISO/IEC 17000:2004 provides the vocabulary and general principles for international conformity assessment based on a functional approach. Any form of conformity assessment reflects the following functions: selection, determination, review and attestation. ISO/IEC Guide 60:2004 recommends good practices for all elements of conformity assessment, including normative documents, bodies, systems, schemes and results. It is intended for use by individuals and bodies who wish to provide, promote or use ethical and reliable conformity assessment services. Next, international standards have been developed for the different categories of conformity assessment bodies and their activities, see the Figure.

Standards for conformity assessment bodies

Conformity assessment body	Standard or guide
Testing and calibration laboratories	ISO/IEC17025: 2005
Certification on bodies for:	
– product certification	ISO/IEC Guide 67: 2004
– management system certification	ISO/IEC 17021: 2006
– certification of persons	ISO/IEC 17024: 2003
Inspection bodies	ISO/IEC 17020

Figure: Standards for conformity assessment bodies (© de Vries)

6 Notified bodies

In the countries of the European Union and the European Free Trade Association, notified bodies are certification or testing organizations that have not only been approved by an accreditation organization, but are officially, through the national authorities, designated to perform special checks that are connected to (European) legislation. In the notifying procedure the national authorities report to the European Commission that they have notified a body which is competent to execute this task for all other EU and EFTA member countries too. The danger of such an indication through national authorities is that organizations which are less competent are also notified. Therefore, most member countries require accreditation of the notified body to guarantee the competence of the organization. Another danger is the development of a monopoly situation when access to other competitive institutions in the same country is obstructed. In spite of the fact that an organization can make use of the services of foreign testing and certification bodies, many organizations, especially the smaller ones, prefer a body that operates in their own country and language.

Notified bodies are qualified to operate within the framework of European legislation. That part of the business world which exports to countries outside Europe will also be interested in having testing and certification bodies in Europe that are accepted by authorities of the countries outside Europe to which they want to export. This would mean that certification activities to comply with the legislation of the export country can be performed locally. For instance, European manufacturers that are exporting to the USA might wish to have their products tested in Europe in such a way that the American Food and Drug Administration (FDA), for example, will accept their product. Conversely, the same applies to testing and certification houses outside

Europe whose clients want to export to Europe and want to have assistance in meeting the requirements of European New Approach Directives (see the Module 'The European Union and the New Approach').
Notified bodies are independent of manufacturing companies. However, some manufacturers have industrial laboratories with excellent assessment qualities. After accreditation, these laboratories can obtain the status 'competent authority' ('competent body'). They may acquire the recognized competence to perform tests that would normally be executed by a Notified Body. Then, the company must take legal and organizational measures to guarantee the legal and organizational independence of the 'competent authority' with respect to the mother organization (and its management).

7 Conformity assessment and international trade

7.1 Mutual Recognition Agreements (MRAs)

For many companies, the market is the world market. Therefore, it would cost them a lot of money if they had to modify their product to the requirements in different national standards and if they had to demonstrate conformity to these standards by using different national certificates. The first problem is solved by replacing national standards by international standards, the second issue asks for common certificates. Then one other issue remains: preferably a certificate issued in country A should preferably also be recognized in country B. In order to achieve the latter situation, so-called Mutual Recognition Agreements (MRAs) have been established.An MRA is an agreement that specifies the conditions by which each party will accept or recognize results of conformity assessment procedures, produced by the other party's conformity assessment bodies or authorities, in assessing conformity to the importing party's requirements. The objective of such mutual recognition is to provide effective market access throughout the territories of the countries with regard to conformity assessment for all products covered under the agreement. If any obstacles to such access arise, consultations will promptly be held.

Following a three-step process leads to an effective MRA. In most cases peer reviews are applied. The main purpose is to ensure that all members of the agreement maintain an appropriate level of professionalism. The three steps are:

1 Harmonization: Agreement on how to assess each other (harmonization of requirements, methods, procedures, competence, integrity, impartiality) re-testing, inspection, evaluation, reporting, approval, complaint handling.
2 Recognition: Confidence between services based on technical and procedural harmonization.

3 Acceptance: Trust in the results of the services, by operators, clients, end users, and authorities.

An example of International Multilateral Recognition Agreements is the IECEE CB Scheme for electrical products (see http://www.iecee.org/cbscheme/cbfunct.pdf).

7.2 World Trade Organization (WTO)

Historically, many nations had for varying reasons developed their own regulations for the import of goods and products, for instance to maintain public health by preventing the import of diseases, or to protect national industries, etc. Nowadays these regulations are frequently perceived as technical barriers to trade (TBTs). The World Trade Organization (WTO) aims to remove these TBTs, while, at the same time, maintaining measures to prevent adverse consequences of free trade with regard to health and safety and sometimes environmental effects. The WTO Agreement on Technical Barriers to Trade tries to ensure that regulations, standards, testing and certification procedures do not create unnecessary obstacles. For further details we refer to the website of the WTO (http://www.wto.org), to the World Trade Report 2005 (World Trade organization, 2005) and to the Module on 'Standardization and Internationals Law'.

8 A case of conformity assessment: The Chinese JMC Landwind entering the European Union

Countries in transition may have a competitive advantage by combining low cost with an acceptable level of quality. In this respect, the ability of China to enter the European market with a car, the JMC Landwind, can be seen as a benchmark. However, getting permission to enter the European market was not self-evident: official tests had to be passed.

The European Union prescribes type approval for all passenger vehicles on the road. Several tests have to be passed to acquire type approval, e.g., crash tests, brake tests, and visual inspection on the presence of accurate lightning, chassis, suspension, etc., as an indication that the car has been properly built, like. The EU directives for crash tests allows a few exceptions: cars above 2500 kg, small series under 500 units per year per member state, and individual vehicle approval.

Vehicles above 2500 kg are difficult to crash test, because the heavy weight barriers cannot take the force of impact. Therefore cars above 2500 kg are not crash-tested for their approval (European Parliament, 1997). An other point of

consideration is 'compatibility': the way two cars react to each other in a crash. When a heavy car hits a light-weight car, problems will occur: the light-weight car will have to deal with forces of the crash, and so will the passengers.

Small series are not crash tested because the costs would increase too much.

In Individual Vehicle Approval, crash tests are not used because there is only one single car and after the test the car will not be usable. Instead, the car is only inspected in terms of whether it is built properly. This type approval is meant to be for the public who may like to import a special car which is not for sale in their country (European Parliament, 1997).

The Landwind entered Europe by acquiring Individual Vehicle Approvals. All these approvals of the JMC Landwind were performed by TÜV in Germany as the Notified Body. When a car has acquired an individual approval in one European member state it is legally permitted on the road in every European member state. (SWOV, 2005) In the case of The Netherlands, the importer Bijvelds chose to import every car on a single basis although the standard commonly used was the type approval for small series and the costs were higher (Vlijm e.a, 2006). Because of the fact that the German TÜV approved all these individual cars, the JMC Landwind was able to enter Europe one by one - a strange entrance which is in conflict with the way the European law should be interpreted.

On the car market, another - voluntary - test is relevant as well: the Euro NCAP test. Euro NCAP is a consortium which includes the governments of Catalonia (a part of Spain), France, Germany, The Netherlands, Sweden and the United Kingdom, motoring organizations represented by the FIA Foundation and ADAC, European consumer groups represented by ICRT and British insurers represented by Thatcham.

The ADAC, the German automobile club, tested the Chinese Landwind for conformity with Euro NCAP directives. A frontal impact test and a side impact test were performed to Euro NCAP standards (ANWB-1, 2005), which are higher then minimum directives of the EU (Euro NCAP-1, 2005). The car was crashed at 64 km/h into a barrier. The driver would not survive this crash and the passengers would suffer serious injuries. The results are shown in the Figure. On the left side the JMC Landwind and on the right side, as a comparison, another car also tested in 2005, the Jeep Grand Cherokee.

The Figure shows that the results of the front impact test of the Landwind were very bad. The result of the side impact test was also dramatic. The head of the driver would probably hit the underside of the roof, causing death. ADAC has been crash-testing cars for more then twenty years and never have the results been so bad.

The injuries of the front impact test JMC Landwind and Jeep Grand Cherokee

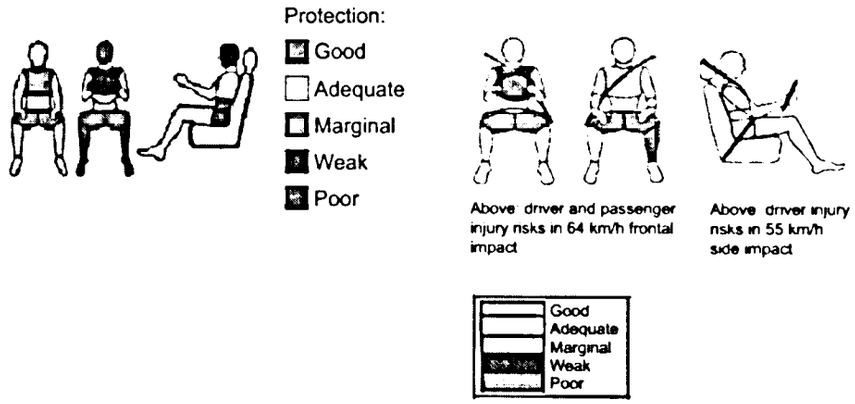


Figure: The injures of the front impact test JMC Landwind and Jeep Grand Cherokee (Source: ADAC-1, 2005 & Euroncap-2, 2005)

These alarming test results were front page news in Western Europe, Autumn 2005. Dr Horst Safarovic of TÜV Nord stated in a conference of the FIA: "Had I been asked to inspect the Landwind and had I found a design of a steering column going straight to the front bumper I would have been extremely careful in giving an approval." (FIA, 2005) This statement suggests that Dr. Safarovic even doubts the results obtained from his own organization.

After the negative press, the Dutch importer Bijvelds asked TÜV for a re-test. The Landwind passed this test with an additional beam in the front to distribute the force of the impact better (Autoweek, 2005). So TÜV judged the car to be safe, but the Dutch consumer organization for car users ANWB and the Dutch Ministry of Transport doubted the result because the steering wheel moved inwards assumingly more then the upper limit of 8 cm prescribed in European legislation. (Vlijm e.a, 2006).

The Landwind was able to gain approval due to a gap in the EU type approval legislation. Moreover, the approval itself seems to be doubtful. After this incident, the European Commission is speeding up new legislation to prevent similar cases in future (FIA, 2005). Chinese car producers are facing a challenge of further enhancing the quality in order to prevent rejection or suffer from bad publicity in future.

9 Trustworthiness of certificates

The Landwind case questions the reliability of certification. In certification practice, there is a tension between the rate of reliability of certification and its cost. Certification is, by definition, based on a decision following review, that fulfilment of specified requirements has been demonstrated. However, fierce price competition between certification bodies appears to affect the trustworthiness of this assurance: it is cheaper to spend less time on the assessments but this may be at the cost of the quality and reliability of these assessments. As a result, certification in general and management system certification in particular is disputed (Seddon, 2001).
Another reason for doubts is that some certification bodies combine certification activities with consultancy. Preferably these activities should not be connected in any way for the same client, otherwise the assessment is not independent. As a consequence, consultancy is only permitted from a company that does not actually perform the accreditation (certification), and the latter work has to be performed by a competitor of the accreditation (certification) body.
Of course, accreditation should contribute to a well-functioning certification system, but in accreditation a conformity assessment body's competence rather than its actual performance is assessed: there is no guarantee that a highly qualified certification body does not approve objects that fail to meet the requirements.
Discussion about the quality of certification is, of course, on the agenda of the IAF. In a statement issued on 17 January 2002 and headed 'IAF Requires High Standards of Integrity from its Members', IAF was; 'concerned at recent public statements questioning the integrity of the conformity assessment programmes operated by accreditation bodies'. It appears to refer to claims by the International Organization for Standardization (ISO) of dishonesty and malpractice. 'IAF is aware of the commercial pressures on certification/ registration bodies and the suppliers they certify that may lead them to act inappropriately.' IAF requires its Accreditation Body Members to apply rules which are designed to identify and stamp out any such inappropriate behaviour. 'IAF is determined to eliminate any practice which brings the conformity assessment system into disrepute. However, IAF is aware that there are in the world a number of organizations which purport to be accreditation bodies or certification/registration bodies which are not Members of IAF or accredited by Members of IAF. IAF cannot act against such bodies, even if malpractice is demonstrated, as it has no legal authority to do so' (Source IAF statement). IAF says in the latter statement 'commercial pressures may lead certification/registration bodies to act inappropriately'. Of course this might be the case in some situations. However, one has to realize that no system will be totally watertight or perfect.

10 Concluding remarks

The globalization of trade has considerably increased the interest and need for standardization and related conformity assessment at the international level. The main parties in a conformity assessment system are supplier (first party), customer (second party), certification body (third party) and accreditation body. Declarations of conformity can be given by first, second and third parties. Objects of conformity assessment include products, services, processes, persons and management systems. International standards support and shape an infrastructure and practice for conformity assessment both at the national and at the international level. The cost of conformity assessment should be balanced against the quality and reliability of the assessments needed to achieve an acceptable level of confidence that the 'objects' meet agreed-upon requirements.

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12 Glossary

Accreditation
The term accreditation originates from the Latin word accredo = meaning to give credit or acknowledgment (authorization), official substantiation. In accreditation an authorized body investigates and certifies that a test laboratory, for example, conducts tests faultlessly in accordance with European standards (EN). Accreditation is a process in which an authoritative body formally recognizes that a body or person is competent to fulfil certain tasks. The basis for accreditation is provided by the EN 45000 standards series.

Accreditation body
A body with formal recognition being competent to carry out specific tasks related to specific types of testing, measurement and calibration.

Approved supplier
A vendor who meets minimum performance criteria with respect to service, delivery and quality and has been added to the company database of approved suppliers.

Audit
Systematic, independent, documented process for obtaining records, statements of fact or other relevant information and assessing them objectively to determine the extent to which specified requirements are fulfilled (ISO/IEC 17000).

Certification
According to the European standard EN 45020 "certification of conformity" is used to mean inspection by an impartial third party to show that a correctly designated product, process or service complies with a specific standard. In the context of legal harmonization, the issuing of a certificate serves as proof that the product meets specific laws or other technical specifications and criteria, i.e. it complies with or conforms to these.

Certification body
Organization that offers certification services.

Conformity
Fulfilment of a requirement (ISO 9000:2005).

Conformity assessment
Systematic assessment of the extent to which a product, process or service fulfils the prescribed requirements.

FAO
Food and Agriculture Organization of the United Nations

First party conformity assessment
Conformity assessment performed by the person or organization that provides the object of conformity assessment (ISO/IEC 17000).

Hazard Analysis Critical Control Point (HACCP)
HACCP is a system of measures for food safety which requires an assessment of food hazards, the establishment of acceptability limits, the monitoring of processes and the implementation, where necessary, of corrective action.

Inspection
Examination of a product design, product, service, process or plant, and determination of conformity specific requirements or on the basis of professional judgment. This broad definition is a gentle reminder of the wide variety of inspection activities that exist. Conformity assessment by inspection is not limited to product and plant, but is equally relevant in other areas such as services and processes.

Inspection body
Body that performs inspection.

IAF
International Accreditation Forum.

Keymark
European mark introduced by CEN/CENELEC as a means through which compliance of products with the relevant European standards can be demonstrated.

Management System
System to establish policy and objectives and to achieve those objectives (ISO 9000:2005).

Mark
A design, symbol, logo, or other mark used to establish the identity and image of a product or service.

Medical device
Any instrument, apparatus, appliance, material or other article, whether used alone or in combination, including the software necessary for its proper application intended by the manufacturer to be used for human beings for the purpose of: diagnosis, prevention, monitoring, treatment or alleviation of disease, diagnosis, monitoring, treatment, alleviation of or compensation for an injury or handicap, investigation, replacement or modification of the anatomy

or of a physiological process, control of conception, and which does not achieve its principal intended action in or on the human body by pharmacological, immunological or metabolic means, but which may be assisted in its function by such means. (Source: European Directive on Medical Devices).

Mutual Recognition Agreement (MRA)
An agreement that specifies the conditions by which each party will accept or recognize results of conformity assessment procedures, produced by the other party's conformity assessment bodies or authorities, in assessing conformity to the importing party's requirements.

Nonconformity
Non-fulfilment of a requirement (ISO 9000:2005).

Notified Body
Also called independent third body or impartial third body. Notified body means "a body that has been made known or announced". They are published in the Official Journal of the European Community. For the purposes of EC directives this is an organization that issues the EC type-examination certificates for compliance with the health and safety requirements contained within the relevant directive. The body must fulfil the conditions specified in the Annex of the directive, be recognized by an authorized organization of an EC Member State as well as the EC Commission and the other Member States and also be nominated by the Member State concerned.

Peer assessment
Assessment of a body against specified requirements by representatives of other bodies in, or candidates for, an agreement group (ISO/IEC 17000). An agreement group is a group of bodies that are signatories to the agreement on which the arrangement is based (ISO/IEC 17000).

Proficiency testing
Determination of laboratory testing performance by means of inter-laboratory test comparisons.

Quality management system
Management system to direct and control an organization with regard to quality (ISO 9000:2005).

Registrar
See: Certification body. The term Registrar refers to the registration of the certification in the certification body's client register. The term Registrar is mainly used in the USA.

Second-party conformity assessment
Conformity assessment performed by a person or organization that has a user interest in the object of conformity assessment (ISO/IEC 17000).

Self Declaration of Conformity (SDoC)
First-party issue of statement, based on a decision following review that fulfilment of specified requirements has been demonstrated (slight modification of ISO/IEC 17000 Clauses 5.2 and 5.4).

Technical barrier to trade (TBT)
Any standard, technical regulation or procedure used in a way to impede international trade rather than for the purposes of achieving a legitimate objective.

Third-party conformity assessment
Conformity assessment performed by a person or body that is independent of the person or organization that provides the object of conformity, and of user interests in that object (ISO/IEC 17000)

UL mark
A mark issued by the American Underwriters Laboratories Inc. The UL Mark on a product means that UL has tested and evaluated representative samples of that product and has determined that they meet UL's requirements.

World Trade Organization (WTO)
International agency which encourages trade between member nations, administers global trade agreements, enforces rules governing global trade and resolves disputes when they arise.

WTO Agreement on Technical Barriers to Trade
A part of the Agreement Establishing the World Trade Organization which aims to ensure that technical regulations, standards, testing and certification procedures do not create unnecessary obstacles to trade, while recognizing the right of countries to adopt necessary standards to achieve some level of protection of their legitimate objectives.

13 Key questions

- Is product certification always advantageous for a producing company?
- In which cases can I make a self declaration of conformity?
- Is it necessary to have the conformity assessment executed by a notified body?

Mingshun Song · Tongyu Lu · Hongkuan Wu

Abstract

This lecture introduces some basic knowledge of metrological management and related topics. Chapter 2 presents some basic and important contents of metrological management. The contents include the dissemination and traceability of the value of quantity, SI, and measurement uncertainty. Chapter 3 contains some basic knowledge of parameter design, which includes three times design and tolerance design. Chapter 4 introduces some important institutions. The emphasis is placed on their role and structure. Chapter 5 includes some knowledge of laboratory accreditation and mutual recognition arrangements, and explains ISO/IEC 17025 related to accreditation. Concluding remarks are in Chapter 6.

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1 Preface

Metrology is an old science, which has evolved over many centuries. Today it is divided into scientific metrology, legal metrology and industrial metrology. Scientific metrology is essential to all those engaged in the various chains of measurement, calibration and accreditation. Legal metrology's primary focus is on measurements that directly affect consumers. Metrological management is the foundation of metrology, which is related to scientific metrology, legal metrology, and industrial metrology.

Quality is not only the reflection of a country's integrated capability of technology and management, but also the foundation of an enterprise to survive and develop. High quality needs high standards. A standard is the basic rule to measure the quality level. And the application of all kinds of standards must be based on appropriate measurement, inspection, and metrological management. So, metrological management has a fundamental relationship with standardisation, and is the necessary foundation of quality management.

There are many subdivisions in the field of metrological management. In this unit, the basic knowledge of metrological management is introduced. This includes: the Système International d'Unités [SI], the dissemination of the value of the quantity, the traceability of the measuring value, evaluation of the measurement uncertainty, parameter design, some famous international and national institutions of metrology, laboratory accreditation, international mutual recognition, etc. The details of metrological management will be introduced in the following lecture.

The relationship between metrology, standardisation and quality

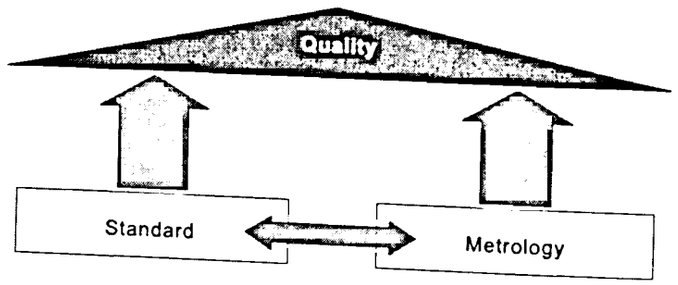


Figure: The relationship between metrology, standardisation and quality (© Song)

2 Metrological Management

2.1 Introduction

Metrology is the science of measurement, which embraces both experimental and theoretical determinations at any level of uncertainty in any field of science and technology. Metrology consists of metrological technology and metrological management. Metrological management regards measurement management systems as its research object. An effective measurement management system ensures that the measuring equipment and measurement processes are fit for their intended use and is important in achieving product quality objectives. The objective of a measurement management system is also to manage the risk that is involved with incorrect measuring equipment and measurement processes that could affect product quality. The methods used for the measurement management system range from basic equipment verification to the application of statistical techniques in the measurement process control (e.g. in design, testing, production and inspection).

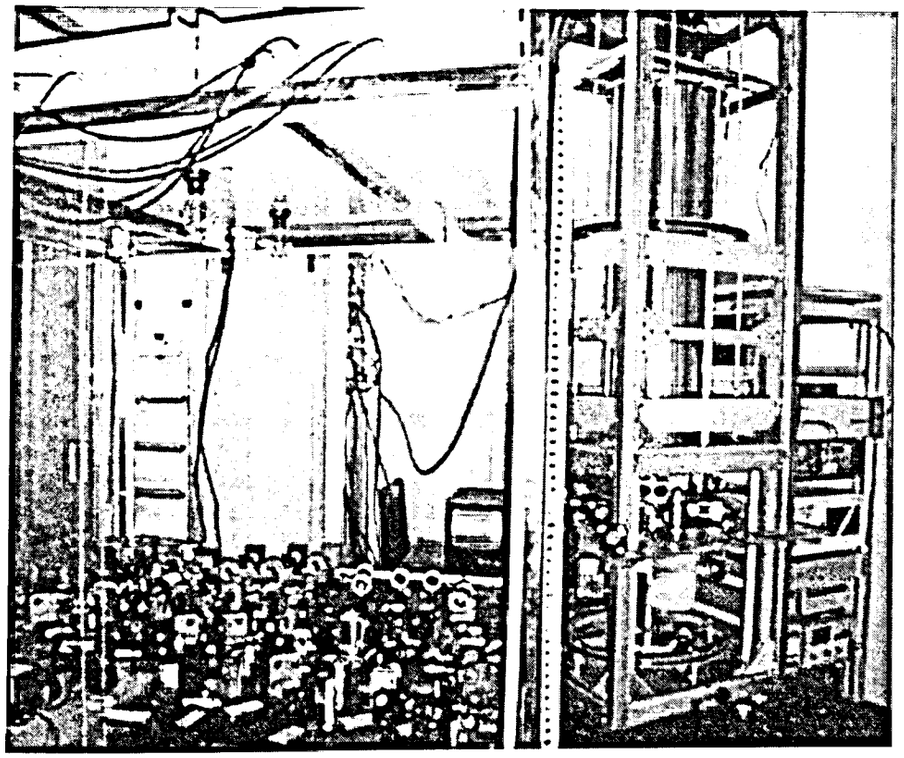


Figure: Caesium atom clock of China (Source: www.nim.ac.cn)

2.1.2 Metrology, Quality and Standards

Metrology and standardisation are the foundations of quality. Without a guarantee of metrology and standardisation, there would be no quality. Measurement and standardisation promote each other, depend on each other and develop together.
Quality can be classified in three layers: conformity quality, customer satisfaction quality and attractive quality. Of the three layers, conformity quality is the foundation of both customer satisfaction quality and attractive quality. What is conformity quality? Conformity quality means that all quality characteristics comply with the parameter requirements prescribed in a standard. And how can you judge whether the quality characteristics agree with the requirement of the standard? A conclusion can only be drawn after measurement and testing using metrological instruments has taken place, in other words, after judging whether the quality conforms to the standard. This is the relationship between standard, metrology and quality. The three parts are mutually dependent and form a whole; and this whole will not exist if any part is missing.

2.1.3 An Example: The Influence of Metrology on Trade

Metrology is the foundation of quality and has a very close relation to standardisation. Metrology, which includes testing instruments, testing methods and testing standards, therefore also plays a very important role in international trade.
The following example illustrates how metrology influences trade. The EU has been implementing new standards for residual pesticides in tea since 1 August 2005. The maximum residue of endosulphane in tea is only 0.01 mg/kg in the new standard, whereas it is 30 mg/kg in the old standard. Zhejiang province is one of the largest producers of tea in China; and a lot of tea from Zhejiang province is exported to the EU every year. Most producers of tea in Zhejiang province have met the technical barriers since the permitted residue of endosulphane in tea was reduced from 30 mg/kg to 0.01 mg/kg. However, because Zhejiang province does not have sufficiently high-precision testing instruments to meet the needs of the new standard, the tea that is exported to the EU must be inspected in the EU; and much substandard tea is detained by customs. During September 2005, the quantity of tea exported from Zhejiang to the EU decreased by 36.2% compared with the same period of the previous year.

2.2 Dissemination of the Value of Quantity

The process of the dissemination of the value of quantity is to transmit gradually, through the different grade standards, the value reproduced by the national or international primary standard to the measuring instruments and tools in the laboratory.
The dissemination of the value of quantity is the fundamental work of metrology and the most important part of legal metrology. The main objective of the dissemination of the value of quantity is to guarantee the accuracy and consistency of the measuring value. The main task of national institutions of metrology, such as NIST and the PTB, is to be in charge of the dissemination of the value of the quantity. (See also: International Vocabulary of Basic and General Terms in Metrology. International Organisation for Standardisation. 1993.)

2.2.1 What is a Standard?

In measurement science, the word 'standard' is used with two different meanings: first, as a widely adopted specification, technical recommendation or similar document; second, as a measurement standard. This unit deals with measurement standards, which can be a physical measure, a measuring instrument, a reference material or a measuring system intended to define, realise, conserve or reproduce a unit or one or more values of a quantity to serve as a reference. For example, the unit of the quantity 'mass' is given with its physical form by a cylindrical piece of metal of one kilogram, which represents the international standard. The hierarchy of measurement standards starts from the international standard at the apex, which is known with the highest precision and goes all the way down to working standards. International measurement standards are standards recognised by an international agreement to serve as the international basis for assigning values to other standards of the quantity. The oldest standard in use today is the International Prototype of the Kilogram, kept at the Bureau International des Poids et Mesures (BIPM) in Sèvres, Paris.

The role of the BIPM is to ensure the international consistency of the highest-level measuring standards in each of the signatories of the international treaty known as the Metre Convention. (See also: International Vocabulary of Basic and General Terms in Metrology. International Organisation for Standardisation. 1993.)

Graph showing the distribution of the value of mass

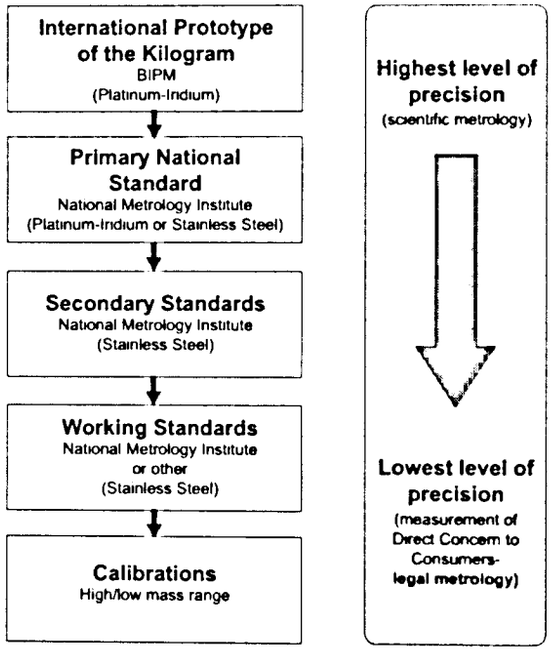


Figure: Graph showing the distribution of the value of mass (Source: www.bipm.fr)

2.2.2 The Types of Metrological Standard

A national measurement standard is often named the primary standard that is recognised by national law to serve in the country as the state basis for assigning values to other standards of the quantity concerned. For example, the custodian of national measurement standards in the USA is the NIST; and in Germany it is the PTB.

- A primary standard is a standard that is designated or widely acknowledged as having the highest metrological qualities and whose value is accepted without reference to other standards of the same quantity. For example, the Josephson device for the realisation of the unit 'volt' is the primary standard of voltage quantity. The stabilised laser used in conjunction with interferometers for the realisation of one metre is the primary standard of the quantity 'length'. The devices are also used as national standards.
- Secondary standards are standards whose value is assigned by comparison to a primary standard of the same quantity. Primary standards are usually used to calibrate secondary standards. A working standard is a standard that is used routinely to calibrate or check material measures, measuring

instruments or reference materials. A working standard is usually calibrated with reference to a secondary standard and may be used to ensure that routine measurements are made correctly.
- A reference standard is a standard generally having the highest metrological quality available at a given location or in a given organisation, from which the measurements made at that location are derived. Calibration laboratories maintain reference standards for calibrating their working standards.

2.2.3 Calibration and Verification

Calibration is simply a comparison of the performance of the measuring instrument or equipment with a reference standard of known accuracy. In addition to this determination and a report of any deviation from the nominal value, it may also include correction (adjustment) to minimise the errors. Properly calibrated equipment provides confidence that the company's products and services meet customer specifications all over the world. In the semiconductor industry, all critical equipment used in manufacturing is required to undergo periodic calibration.
Another commonly encountered term in relation to calibration is verification. Verification is not the same as calibration because it refers to the comparison of the measurement results against a specification, usually the performance figures published by manufacturers. (See also: International Vocabulary of Basic and General Terms in Metrology. International Organisation for Standardisation. 1993.)

2.3 The Traceability of the Measuring Value

When some measurements are carried out, it is necessary to refer back to the national measurement standard or the international standard through an unbroken chain of comparisons. If this is not done, the measurement results would be incomparable and inaccurate.
The traceability is the process of tracing back the measuring value in the field to the national or international primary standard step-by-step through the different measurement uncertainties. The traceability is another important metrological system that assures the accuracy and consistency of the national or regional measuring value. Companies and organisations take part in the traceability work voluntarily for the quality assurance of their products or services. The basic concept behind calibration is that the measuring equipment should be tested against a standard of higher accuracy. To illustrate this, the following is a typical hierarchical relationship between the various levels of calibration/measurement activities within a company:

National Standard	Accurate to 0.002%
Calibration Laboratory	0.01%
Company 'Master' Item	0.07%
Company Production Equipment	1.0%
Finished Product	10.0%

These calibrations need to be carried out on a planned, periodic basis with evidence of the comparison results being recorded and maintained. The records must include identification of the specific standards used (which must be within their assigned calibration interval), as well as the methods/conditions used in the calibration process. These records should demonstrate an unbroken chain of comparisons that ends at the agency that is responsible for maintaining and developing a country's measurement standards. The agency is generally known as a national metrology institution. This demonstrable linkage to national standards, with known accuracy, is known as 'traceability'. (See also: International Vocabulary of Basic and General Terms in Metrology. International Organisation for Standardisation. 1993.)

Calibration traceability

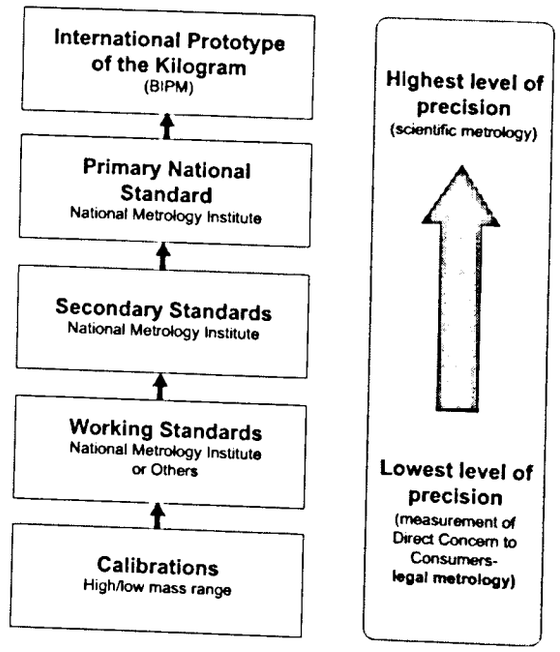


Figure: Calibration traceability (Source: www.bipm.fr)

2.4 International System of Units

The 11th General Conference on Weights and Measures (1960) adopted the name Système International d'Unités (International System of Units, international abbreviation SI), for the recommended practical system of units of measurement.
The 11th CGPM laid down rules for the prefixes, the derived units and other matters. The base units are the seven well-defined units that are regarded as dimensionally independent by the convention.

SI base units

Base quantity	Name	Symbol
Length	Metre	m
Mass	Kilogram	kg
Time	Second	s
Electric current	Ampere	A
Thermodynamic temperature	Kelvin	K
Amount of substance	Mole	mol
Luminous intensity	Candela	cd

Figure: SI base units (Source: www.bipm.fr)

The SI structure

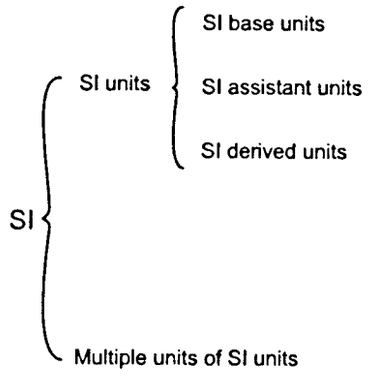


Figure: The SI structure (Source: www.bipm.fr)

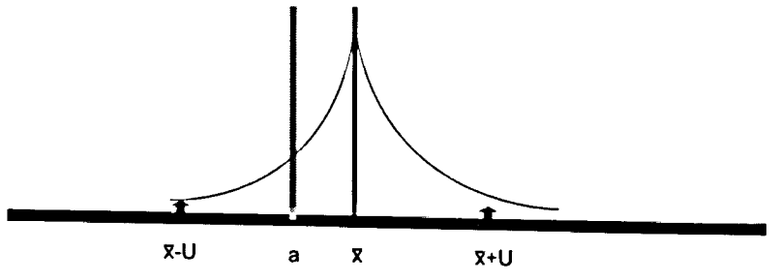
They are the metre, the kilogram, the second, the ampere, the kelvin, the mole and the candela. Derived units are those formed by combining the base units according to the algebraic relations linking the corresponding quantities. The names and symbols of some of the derived units can be replaced by special names and symbols. For example, Hz is the symbol for the unit of frequency, hertz. The SI is not static. It evolves to match the developing requirements for measurement. Currently, it is widely accepted internationally and is the common language in the fields of science, technology, education, etc. (See also: The International System of Units (SI), 7th edition. Organisation Intergouvernementable de la convention de mètre. 1998.)

2.5 Measurement Uncertainty

2.5.1 What is Measurement Uncertainty?

In ordinary use, the word 'uncertainty' does not inspire confidence. However, in a technical sense, such as 'measurement uncertainty' or 'uncertainty of a testing result', it carries a specific meaning. It is a parameter associated with the result of a measurement (e.g. a calibration or testing) that defines the range of values that could reasonably be attributed to the measured quantity. When the uncertainty is evaluated and reported in a specified way, it indicates the level of confidence that the value actually lies within the range defined by the uncertainty interval.

Illustration of measurement uncertainty



a: is the true value of the measureand;
$\bar{x}$: is the estimate of the measureand;
U: is the uncertainty of the measurement of the measureand.

Figure: Illustration of measurement uncertainty (© Song)

2.5.2 How Does Measurement Uncertainty Arise?

Any measurement is subject to imperfections. Some of these are due to random effects, such as short-term fluctuations in temperature, humidity and air-pressure or variability in the performance of the measurer. Repeated measurements will show variation because of these random effects. Other imperfections are due to the practical limits to which correction can be made for systematic effects, such as offset of a measuring instrument, drift in its characteristics between calibrations, personal bias in reading an analogue scale or the uncertainty of the reference standard.

2.5.3 Why is Measurement Uncertainty Important?

Uncertainty is a quantitative indication of the quality of the result. It gives an answer to the question: How well does the result represent the value of the quantity being measured? It allows users of the result to assess its reliability. Confidence in the comparability of results can help to reduce barriers to trade. Often, a result is compared with a limiting value defined in a specification or regulation. In this case, knowledge of the uncertainty shows whether the result is well within the acceptable limits or not. Occasionally, if a result is very close to the limit, then the uncertainty must be considered because there is a risk that the level of uncertainty may place the result outside the limit.

The general method of evaluating uncertainty

$$\bar{x} = \frac{\sum_{i=1}^{n} x_i}{n} \qquad s = \sqrt{\frac{\sum_{i}^{n} (x_i - \bar{x})^2}{n}}$$

$$S_{\bar{x}} = \frac{S}{\sqrt{n}} \qquad U = k \cdot S_{\bar{x}}$$

x_i	is a measuring value
s	is a measuring value standard deviation
$S_{\bar{x}}$	is the standard deviation of the mean
n	is the amount of the measuring data
$\bar{x}$	is the mean
U	is the expanded uncertainty of the mean

Figure: The general method of evaluating uncertainty (© Song)

2.5.4 Measurement Uncertainty in Laboratory Accreditation

Accreditation bodies are responsible for ensuring that accredited laboratories meet the requirements of ISO/IEC 17025. This standard specifies appropriate methods to estimate measurement uncertainty. These methods are based on the Guide to the Expression of Uncertainty in Measurement (GUM), which is published by ISO and endorsed by the major international professional bodies. It is a weighty document and most international accreditation communities have taken up its principles. Many organisations, such as NIST, have produced simplified or more specific guidance based on GUM.
(BIPM, IEC, IFCC, ISO, IUPAC, IUPAP, OIML, Guide to the expression of uncertainty in measurement (GUM), corrected and reprinted 1995.)

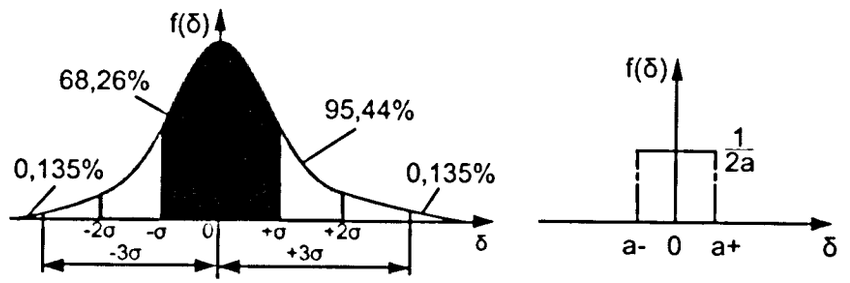
2.5.5 How is Measurement Uncertainty Evaluated?

Uncertainty is a consequence of random effects. It is evaluated by combining a number of uncertainty components. The components are quantified either by evaluation of the results of several repeated measurements or by estimation based on data from records, previous measurements, knowledge of the equipment and experience of the measurement.

- Standard deviation and statistical distribution: In most cases, repeated measurement results are distributed in the familiar bell-shaped curve or normal distribution, in which there is a greater probability that the value lies closer to the mean than to the extremes. The measurement uncertainty evaluation based on repeated measurements is derived from statistical theory; and the key parameter is the standard deviation. Uncertainty components are also expressed as standard deviations, most of which are characterised by the normal distribution. But there are some measurement quantities based on other distributions. For example, if every measurement value has an equal probability within the bounds (upper and lower limits), the uncertainty must be estimated in line with a rectangular distribution. There are simple mathematical expressions to evaluate the standard deviation and other distributions encountered in measuring uncertainty evaluation.
- Combined standard uncertainty and expanded uncertainty: The method of combining the uncertainty components is aimed at producing a realistic rather than pessimistic combined uncertainty. The combined standard uncertainty is calculated via the square root of the sum of the squares of the separate components (the root sum square method). Usually, an expanded uncertainty is reported, which is the combined standard uncertainty multiplied by a coverage factor. The greater this factor, the larger the uncertainty interval and the higher the level of confidence that the value is within that interval. For a level of confidence of approximately 95%, a coverage factor of 2 is used. When uncertainty is being reported, it is important to indicate the coverage factor or state the level of confidence, or both.

Uncertainty is an unavoidable part of any measurement. It starts to matter when results are close to a specified limit. A proper evaluation of uncertainty is good professional practice and can provide laboratories and customers with valuable information about the quality and reliability of the result. In addition to calibration, other testing parameters are required to evaluate uncertainty. (See also: BIPM, IEC, IFCC, ISO, IUPAC, IUPAP, OIML, Guide to the expression of uncertainty in measurement, corrected and reprinted 1995.)

Normal and rectangular distribution



The Curve of the Normal Distribution — The Chart of Rectangular Distribution

Figure: Normal and rectangular distribution (© Song)

3 Parameter Design

Any measurement must be based on standards. These standards consist of many quality parameters. In fact, measurement is the process of measuring the values of the quality parameters. Thus, the design of the quality parameters influences the design and application of the measuring methods and instruments. Therefore, the design of quality parameters is not only an important part of standardisation, but also the fundamental work of metrological management. The basic parameter design methods, including three times design and tolerance error design, are introduced in the following.

3.1 Three Times Design

The three times design suggested by Dr. Taguchi includes system design, parameter design and tolerance error design.

3.1.1 First Time - The System Design

The aim of system design is to create a new system. Through system design, we can ascertain the structure of products, including raw materials, components, accessories and parts assembly systems and determine the target value and tolerance error of product quality, so as to make a product achieve its required function.

3.1.2 Second Time - The Parameter Design

Parameter design is the core stage of product design and is carried out after system design. The basic idea of parameter design is to decrease the influence of all kinds of disturbances so as to make the fluctuation in the quality of the designed product smaller and more stable. This is done by selecting all the system parameters (including raw materials, components and parts, etc.).
There are two models in the product design process:

- The calculation model: If the functional relationship between the product quality parameters and the characteristics of the machinery is known, the theoretical formula to calculate the values of quality parameters can be used; and the product quality characteristics will be kept within small boundaries with a good level of consistency.
- The experiment model: If the functional relationship between the product quality parameters and the characteristics of the machinery is not known, the only way to obtain the values of the quality parameters is through experiment.

3.1.3 Third Time - The Tolerance Error Design

Tolerance error design is the last step in product design. After the system design and the parameter design are completed, the tolerance error must be determined. In the tolerance error design, economy should be considered, namely whether or not it is necessary to assign a smaller tolerance error to the parameters that have a greater influence.

3.2 Tolerance Error Design

3.2.1 The Quality Loss Function

Disturbance causes fluctuation of product function; and fluctuation results in loss of quality. How do people measure the loss caused by the function fluctuation? Dr. Taguchi offers the concept of quality loss function, which can combine function fluctuation and economic loss.

- The definition of the quality loss function: Suppose the product quality parameter is Y and the expected value is m. If $Y \neq m$, then the fluctuation will cause a loss. The bigger $|Y-m|$ is, the larger the loss. Let the corresponding quality loss function of the product quality parameter Y be L(Y). If L(Y) has the second derivative at Y = m, then according to the Taylor formula , the following applies:

$$L(Y) = L(m) + \frac{L'(m)}{1!}(Y-m) + \frac{L''(m)}{2!}(Y-m)^2 + \cdots$$

When Y = m, L(Y) =0, i.e. L(m)=0 .
And since L(Y) is the extreme, so $L'(m)=0$. The high orders above the second order are omitted to give $L(Y) = K(Y-m)^2$

(1) Where $K = L''(m)/2!$ is the constant not dependent on Y. The function represented by the formula (1) is the quality loss function.If there are n number of products and the quality parameter values respectively are Y_1, Y_2,...Y_n, then the average quality loss of product is

$$\bar{L}(Y) = K[\frac{1}{n}\sum_{i=1}^{n}(Y_i - m)^2]$$

(2) Formulae (1) and (2) show that the loss caused by the fluctuation of quality parameter value is proportional to the square of the error or the average square error. The loss may be caused by the unqualified but also by the qualified product. The farther the quality parameter values deviate from the expected value, the greater will be the loss. This is the new concept of product quality suggested by Dr. Taguchi.

- The method to confirm K

a. To calculate K through the function limit Δ_0 and the loss A_0
The function limit refers to the limit value that can be used to judge whether the product works normally.

When $|Y-m| \leq \Delta_0$, the product works normally.

When $|Y-m|>\Delta_0$, the product loses its function.

Suppose the loss function is A0, therefore using formula (1),
it can be expressed as:

$$K=\frac{A_0}{\Delta_0^{\,2}}$$

b. To calculate K via the tolerance error and the loss of disqualification A
The tolerance error refers to the limit in judging whether the product is qualified or not.

When $|Y-m|\leq\Delta$, the product is qualified;

When $|y-m|>\Delta$, the product is unqualified.
If the product is unqualified, the factory can deal with it by rejection, degradation or return for repair, etc. At this stage, the loss suffered by the factory is A.
From the formula (1) it can be expressed as

$$K=\frac{A}{\Delta^2}$$

The curve of loss function (1)

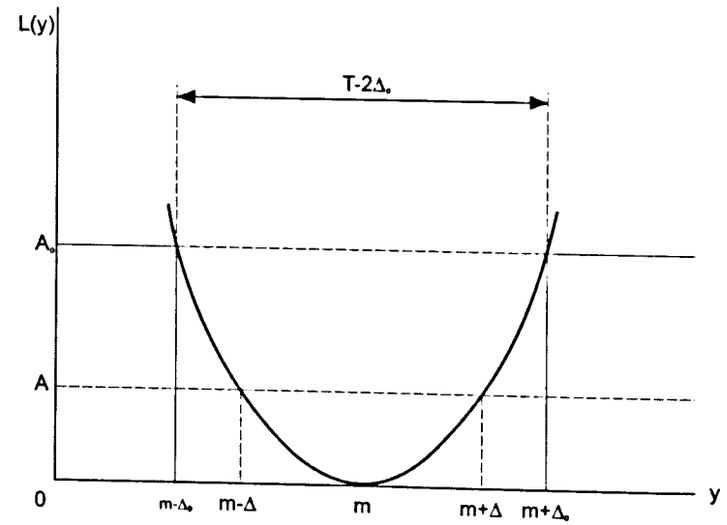


Figure: The curve of loss function (1) (© Song)

The curve of the loss function (2) (3)

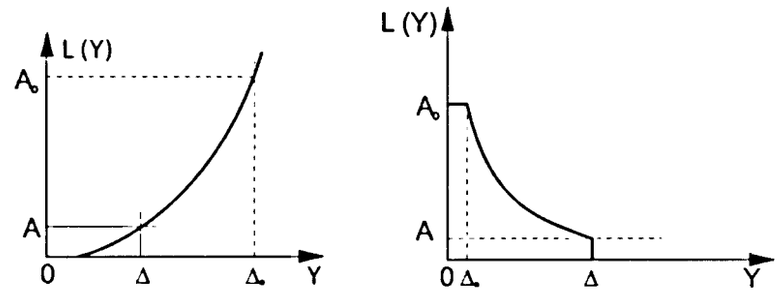


Figure: The curve of the toss function (2) (3) (© Song)

3.2.2 A Method to Confirm the Tolerance Error

In this section, a method to confirm the tolerance error in the product specification and the technology document will be introduced.

- The definition of the safety coefficient: The safety coefficient defined by Dr. Taguchi is a concept in quality engineering. It has different forms in engineering technology.
  Suppose: A_0 is the average loss when the product reaches the function limit, namely the loss borne by the customer.
  And, A is the factory's loss when the product is unqualified.
  Then the safety coefficient φ is equal to

$$\varphi=\sqrt{\frac{A_0}{A}}$$

Since $A_0 > A$, the safety coefficient is greater than 1. Hence, for products requiring high safety, the corresponding safety coefficient φ is greater. Japanese companies often adopt the safety coefficient: φ = 4:5 .

- The expected value of the tolerance error
  The relationship between the expected value of the tolerance error Δ and the function limit Δ_0 is

$$\Delta=\sqrt{\frac{A}{A_0}}\Delta_0$$

When both the function limit φ and the safety coefficient φ are known, the tolerance Δ can be derived from the equation

$$\Delta = \frac{\Delta_0}{\varphi}$$

3.2.3 The Tolerance Error Design

The tolerance error design is related to the material, equipment, production mode, measurement instruments, etc. The total loss, which is related to the tolerance error, is equal to the sum of production cost and quality loss. The tolerance error design aims to minimise the total loss.
Suppose the production cost is P and the quality loss is L_1, then the total loss L_T is
$L_T = P + L$

The best condition for the tolerance error design is the extreme point of L_T which guarantees the balance between quality loss and production cost.
Therefore the tolerance error design is based on the quality loss function, which is used to calculate the loss in quality absorbed by the customer. When the tolerance error is calculated for the expected value of parameters, the quality

$$L(Y) = \frac{A_0}{\Delta_0^2}(Y-m)^2$$

loss function of the single product is
When the quality parameter values of n number of products are Y_1, Y_2,...Y_n, the average loss function is

$$\bar{L} = \frac{A_0}{\Delta_0^2} V_T \quad \text{, where} \quad V_T = \frac{1}{n}\sum_{i=1}^{n}(Y_i - m)^2$$

The tolerance error can be derived from the equation $\bar{L} = \frac{A_0}{\Delta_0^2} V_T$.

(See also: DeVor, Richard E., Tsong-hoe chang, John W. Sutherland. (1992). Statistical Quality Design and Control - Contemporary Concept and Methods. Macmillan Publishing Company, New York, USA.)

4 International Institutions and Organisations of Metrology

There are many national and international institutions directly related to metrology. They play a very important role in the development of metrology. Some famous international and national institutions of metrology are introduced in this section.

4.1 BIPM

4.1.1 Introduction

The Bureau International des Poids et Mesures (BIPM) was set up by the Metre Convention and has its headquarters near Paris, France. It is financed jointly by the Member States of the Convention and operates under the exclusive supervision of the CIPM. Its mandate is to provide the basis for a single, coherent system of measurements throughout the world which are traceable to the International System of Units (SI). This task takes many forms, from direct dissemination of units (as in the case of mass and time) to coordination through international comparisons of national measurement standards (as in length, electricity and ionising radiation).
The BIPM has an international staff of over 70; and its status vis-à-vis the French government is similar to other intergovernmental organisations based in Paris.

4.1.2 The Role of BIPM

The BIPM's original mission was to promote and extend the metric system throughout the world by maintaining the International Prototypes of the metre and the kilogram, constructing copies of the prototypes, maintaining the new prototypes, comparing the various national systems of measurement standards with the prototypes of the kilogram and the metre and perfecting the measurement methods in order to promote metrology and thereby ensure worldwide conformity of measurements. To accompany industrial development, the scope of the BIPM was extended to new areas of technology - electrical measurement standards (1937), photometric measurement standards (1937), ionising radiation measurement standards (1960), measurement standards in time (1988) and measurement standards in chemistry (2000).

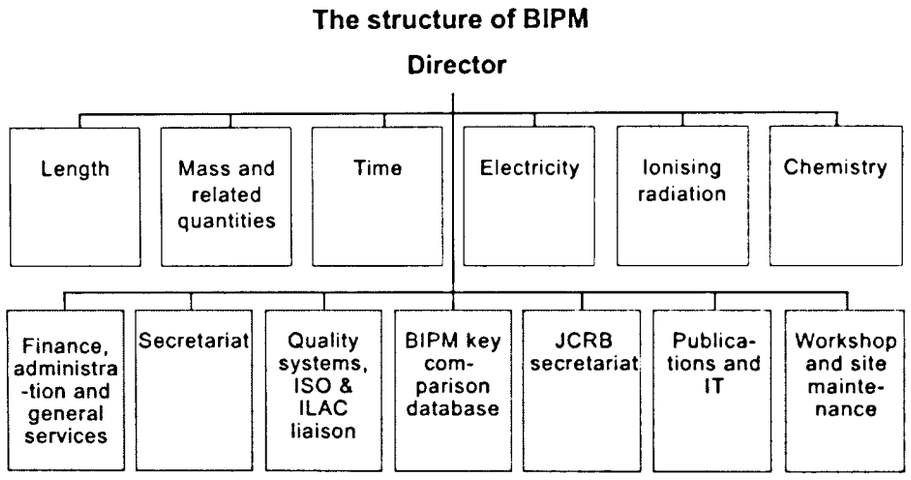


Figure: The structure of BIPM (Source: www.bipm.fr)

4.1.3 Mechanical Workshop

BIPM has a high-quality precision mechanical workshop equipped appropriately in terms of machines and competent, multi-skilled mechanics to conceive, design and carry out its projects. Since June 2001, the workshop has been located in the Pavillon du Mail, which provides a modern and well-adapted environment.
Close collaboration with the scientific and technical staff allows the workshop to meet the precise needs of the BIPM laboratories and to produce the instruments required.
The workshop also produces platinum-iridium prototype masses for Member States of the Metre Convention. Since 2002, a new fabrication procedure has been put in place, replacing diamond tooling in favour of complete polishing.
The workshop is also involved in general maintenance of the BIPM buildings, particularly the task of servicing the air-conditioning that is essential for the scientific laboratories.

4.2 OIML

4.2.1 Introduction

• What is the OIML
The International Organisation of Legal Metrology (OIML) is an intergovernmental treaty organisation whose membership includes Member States, countries which participate actively in technical activities, and Corresponding Members, countries which join the OIML as observers. It was established in 1955 in order to promote the global harmonisation of legal metrology procedures. Since that time, the OIML has developed a worldwide technical structure that provides its members with metrological guidelines for the preparation of national and regional requirements concerning the manufacture and use of measuring instruments for legal metrology applications.

• Definition of legal metrology
Legal metrology is the entire body of the legislative, administrative and technical procedures established by reference to public authorities and implemented on their behalf in order to specify and to ensure, in a regulatory or contractual manner, the appropriate quality and credibility of measurements related to official controls, trade, health, safety and the environment.

• OIML Certificate System for Measuring Instruments
The OIML Certificate System for Measuring Instruments was introduced in 1991 to facilitate administrative procedures and lower the costs associated with the international trade of measuring instruments subject to legal requirements. The System allows a manufacturer to obtain an OIML Certificate and a Test Report indicating that a given instrument pattern complies with the requirements of the relevant OIML International Recommendations.
Certificates are delivered by OIML Member States that have established one or several Issuing Authorities responsible for processing applications by manufacturers who wish to have their instrument types and patterns certified.
OIML Certificates are accepted by national metrology services on a voluntary basis determined by the development of an atmosphere of mutual confidence and recognition of test results developed between OIML members. The System serves to simplify the approval process for manufacturers and metrology authorities by eliminating costly duplication of application and test procedures.

4.2.2 OIML Structure

• International Committee of Legal Metrology (CIML)
As the steering committee for OIML, the CIML meets annually to review the Organisation's technical progress and administrative operations. The Committee

is composed of one appointed representative from each OIML Member State. Certain CIML Members are appointed Honorary CIML Members on retirement from their position and in recognition of their outstanding contribution to the work of the Organisation.

• **International Conference**
OIML Member State delegations, observers from Corresponding Members and liaison officers from international and regional institutions assemble every four years to define general policy and budgetary planning for the Organisation and to promote national implementation of OIML metrological guidelines.

• **OIML Technical Committees and Subcommittees**
International consensus in the legal metrology community is reached through Technical Committees and Subcommittees, the composition of which includes representatives from Member States, international standardisation and technical organisations, manufacturers' associations and regional regulatory bodies. Under the coordination of a secretariat, experts establish international technical guidelines for the metrological performance and testing procedures of legally controlled measuring instruments.

• **Presidential Council**
Working with the President and Vice-Presidents of OIML, a limited number of Committee Members, appointed by the President, act as an advisory group for the President.

• **Liaison Activities**
OIML, together with BIPM, works closely with the Metre Convention and its executive body to pursue international harmonisation of legal metrology by participating in inter-institutional coordination of technical work and in exchanges of information and expertise. Through liaisons with more than 100 international and regional institutions with activities in metrology, standardisation and related fields, OIML work bears the trademark of global cooperation aimed at promoting credible measurement practices.

• **Technical Seminars**
Technical seminars are regularly organised by OIML, often together with one or more Member States, or in conjunction with other liaison institutions. These seminars aim at highlighting advances in measurement instrumentation and metrological procedures. They provide a valuable opportunity for government and industry exchanges and reflect the diversity of OIML activities which extend into areas such as mass, volume and pressure measurement, acoustics and vibration, pre-packaging, temperature, medical instrumentation and environmental pollution.

4.3 ILAC

4.3.1 Introduction

The International Laboratory Accreditation Cooperation (ILAC) is an international organisation between the various laboratory accreditation schemes operated throughout the world. Founded more than 20 years ago, ILAC first started as a conference in 1978 with the aim of developing international cooperation for facilitating trade by promotion of the acceptance of accredited testing and calibration results. ILAC was formalised as an organisation in 1996 when 44 national bodies signed a Memorandum of Understanding (MOU) in Amsterdam. This MOU provided the basis for the further development of the cooperation and the eventual establishment of multilateral recognition agreement between ILAC member bodies. It provides the focus for:

- developing and harmonising laboratory and inspection accreditation practices;
- promoting laboratory and inspection accreditation to industry, governments, regulators and consumers;
- assisting and supporting developing accreditation systems;
- global recognition of laboratories and inspection facilities via the ILAC Arrangement, thus facilitating;
- acceptance of testing, inspection and calibration data accompanying goods across national borders.

4.3.2 The Purpose of ILAC

The aim of the ILAC Arrangement is to develop a global network of accredited testing, calibration and inspection facilities that can be relied on to provide accurate data. The ILAC Arrangement came into effect on 31 January 2001 and provides technical underpinning to international trade by promoting cross-border stakeholder confidence and acceptance of accredited laboratory data. Until the advent of the ILAC Arrangement, there had been no multi-lateral mutual recognition agreement in laboratory accreditation. This was a hindrance for some types of international trade, particularly for those products that had to undergo re-testing or re-calibration upon entry to importing countries. The ILAC Arrangement will facilitate trade of this type of product.

4.3.3 ILAC Arrangement

On 2 November 2000, 36 full members of the International Laboratory Accreditation Cooperation (ILAC) from 28 economies worldwide signed an 'arrangement' in Washington DC., to promote the acceptance of technical testing and calibration data for exported goods. At the end of 2004, over 40 laboratory

accreditation bodies signed the multi-lateral, mutual recognition arrangement (the ILAC Arrangement) to promote the acceptance of accredited testing and calibration data. The ILAC Arrangement provides significant technical underpinning to international trade. The key to the arrangement is the developing global network of accredited testing and calibration laboratories that are assessed and recognised as being competent by ILAC Arrangement signatory accreditation bodies. The signatories have, in turn, been evaluated by their peers (against the requirements of ISO (Guide 58) and shown to meet ILAC's criteria for competence. Now that the ILAC Arrangement is in place, governments can take advantage of it to further develop or enhance trade agreements. The ultimate aim is increased industry and government use and acceptance of the results from accredited laboratories, including results from laboratories in other countries. In this way, the free-trade goal of 'a product tested once and accepted everywhere' can be realised.
As part of its global approach, ILAC also provides advice and assistance to countries that are in the process of developing their own laboratory accreditation systems. These developing systems are able to participate in ILAC as associate members and access the resources of ILAC's members.
In conjunction with ILAC, specific regions have also established their own accreditation cooperations, notably in Europe (EA) and Asia-Pacific (APLAC). These regional cooperations work in harmony with ILAC and are represented on ILAC's board of management. ILAC is encouraging the development of such regional cooperations in other parts of the world.
Hence, ILAC is the world's principal international forum for the development of laboratory accreditation practices and procedures and the promotion of laboratory accreditation as a trade facilitation tool.)

4.4 PTB

4.4.1 Introduction

The Physikalisch-Technische Bundesanstalt (PTB) is the national metrology institution of the Federal Republic of Germany. It provides scientific and technical services. Metrology is PTB's core competence and it measures with the highest degree of accuracy and reliability.
PTB performs fundamental research and development work in the field of metrology. This is the basis for all the tasks entrusted to it, which include the areas concerning: the determination of fundamental and natural constants; the realisation, maintenance and dissemination of the legal units of the SI; safety engineering; services and metrology for the area regulated by law and for industry; as well as technology transfer. Fundamental research work performed by the PTB itself using the latest technologies will enable it to ensure on a long-term basis that its metrological competence is recognised on the international level and is extended further.

4.4.2 Functions

The PTB as the guardian of the units
The basis of all measurements is also a basis of the PTB's work where almost everything revolves around the seven SI base units. The PTB maintains the German copy of the 'original kilogram', which is the international prototype kilogram. Time is 'made' in the PTB headquarters in Brunswick; while the temperature is 'made' by one of the PTB divisions domiciled in Berlin. Under the Units Act, the PTB is bound to realise and disseminate the legal units and to maintain the respective embodiments (prototypes and standards). This task has an impact on the four fields of the PTB's work. For example, upon approval (coming under legal metrology) or upon calibration (part of the services for industry) measuring instruments must be linked up with the respective national standard. Comparing its own standards with those of other countries is among the tasks that the PTB performs on the international level. Finally, it is the task of the PTB's fundamental research to constantly look for better methods for the realisation and dissemination of the units.

The PTB in the service of the public
As the national institution for science and technology and the superior technical authority of the Federal Ministry of Economics, the PTB carries out a great variety of tasks in accordance with national and international laws.

The PTB in the worldwide network of metrology
The international tasks of the PTB cover managing cooperation among the many different metrology organisations and national metrology institutions all over the world, in addition to providing practical support for setting up a metrological infrastructure in developing and threshold countries. In both cases, the same objective is pursued, namely international harmonisation of metrology. To ensure that trade proceeds unhindered, one kilogram must be one kilogram everywhere and one metre must be one metre. A great number of measures and regulations must be harmonised so that they comply worldwide. In Europe, this harmonisation has largely been reached; but on the global scale, it has not yet been fully attained. The various international agreements are important milestones on this long way.

4.5 NIST

4.5.1 Introduction

Founded in 1901, NIST (National Institute of Standard and Technology) is a non-regulatory federal agency within the US Commerce Department's Technology Administration. NIST's mission is to develop and promote measurement, standards and technology to enhance productivity, facilitate trade and improve the quality of life. NIST carries out its mission in four cooperative programs:

- the NIST Laboratories, conducting research that advances the nation's technology infrastructure and is needed by US industry to continually improve products and services;
- the Baldrige National Quality Program, which promotes performance excellence among US manufacturers, service companies, educational institutions and health care providers; conducts outreach programs and manages the annual Malcolm Baldrige National Quality Award which recognises performance excellence and quality achievement;
- the Manufacturing Extension Partnership (MEP), a nationwide network of local centres offering technical and business assistance to smaller manufacturers;
- and the Advanced Technology Program, which accelerates the development of innovative technologies for broad national benefit by co-funding R&D partnerships with the private sector.

NIST has an operating budget of about $771 million and operates in two locations: Gaithersburg, MD (headquarters - 234-hectare/578-acre campus) and Boulder, CO (84-hectare/208-acre campus). NIST employs about 3,000 scientists, engineers, technicians and support and administrative personnel. About 1,800 guest researchers complement the staff. In addition, NIST partners with 2,000 manufacturing specialists and staff at affiliated centres around the country.

4.5.2 Products and Services

NIST's support to US industry is in the form of the following products and services:

- Assistance to smaller manufacturers - Small to mid-sized manufacturing firms can get help in solving business and technical problems from the NIST Manufacturing Extension Partnership. The MEP network has outreach centres in every state to help manufacturers with productivity, modernisation, information technology and other issues that affect their ability to compete in the global marketplace.
- Calibrations - NIST calibration services help makers and users of precision instruments to achieve the highest possible levels of measurement quality and productivity. These services directly link a customer's instrument or transfer standard to national and international standards.
- Databases - NIST customers can purchase a wide variety of highly accurate scientific and technical databases through the NIST Standard Reference Data Program. A number of popular NIST data collections, such as the Chemistry Web Book and Physical Reference Data, are available for free on the World Wide Web.
- Laboratory accreditation - Public and private laboratories can demonstrate their competence to perform tests and calibrations in a specific field by earning accreditation in the National Voluntary Laboratory Accreditation Program.
- Measurement and standards research - Researchers in NIST Laboratories, located in Gaithersburg, MD and Boulder, CO, conduct research in physical and engineering sciences. The labs respond to industry needs for measurement methods, tools, data and technology. NIST researchers collaborate with colleagues in industry, academic institutions and other government agencies.

4.5.3 Research Areas

NIST is also one of the most well-known scientific research institutes in the world. The main research areas include the following:

- Electromagnetics - fundamental microwave quantities, high-speed microelectronics, electromagnetic compatibility, antennas, electromagnetic properties of materials, advanced measurement methods and standards for the magnetic data storage and superconductor power industries;
- Electromagnetic technology - solutions to metrology problems using solid-state quantum effects, low temperatures to reduce thermal noise and state-of-the-art lithography;
- Materials reliability - measurement methods and standards enhancing the mathematical and computational sciences - design of experiments, modelling, analytical methods and algorithms for science;
- Optoelectronics - measurement technology, standards and traceability for the optoelectronic industry;
- Physical and chemical properties - measurements, standards, data and models for the thermo physical/chemical properties of gases, liquids and solids and for low-temperature refrigeration systems;
- Laser and optical physics;
- Statistical modelling and analysis - modern statistical experimental design, statistical modelling, data analysis and process control procedures;
- Time and frequency - standards of time and frequency, dissemination of timing information using radio broadcasts and the Internet.

4.5.4 Features of the American Metrological System

The metrological system of the USA has its special features. It is generally the same as the metrological system of the UK, but different from most other member states of the EU. The biggest difference is that it adopts some different systems of unit. Currently, in the USA and the UK, the British system of units is still used; and both the British system of units and SI coexist in the two countries. But in the EU, only the SI has been adopted. The system of units is the foundation of a national metrological system, which is validated and guaranteed by law. At present, almost all the countries in the world have adopted SI. Therefore, the disunity of the system of units in the USA and UK represents an unnecessary obstacle in international trade. The commercial ministry of the USA has analysed the trade loss resulting from the implementation of the British system of units and found that if the USA had adopted SI in 1965, by 1975, gross exports would have increased by almost $600 billion.

5 Laboratory Accreditation and Mutual Recognition

5.1 Laboratory Accreditation

5.1.1 Accreditation

Experimentation is a method of observing the changes and results of certain scientific phenomenon by creating special conditions. A laboratory is an institute that calibrates and tests the procedure of experimental certification. The aim of the existence of laboratory is to provide society with accurate and credible testing data and results.
Laboratory Accreditation provides a means of determining the competence of laboratories to perform specific types of testing, measurement and calibration. The general requirements for laboratory accreditation are contained in ISO/IEC 17025. This standard contains quality system requirements and technical requirements that the laboratories must meet. Laboratory accreditation requirements, however, go beyond just ISO/IEC 17025.

5.1.2 The Benefits of Laboratory Accreditation

- Enhancing the laboratory competence in order to be recognised nationally and internationally;
- Increasing the confidence in and the reliability of test results or calibration results generated by the accredited laboratory;

- Acceptance of testing and calibration certificates from accredited laboratories in countries who are members of APLAC and ILAC Mutual Recognition Arrangements;
- Facilitating trade in national and international markets;
- Reducing technical barriers to trade, by eliminating the need for repeated testing in the importing country;
- The accredited laboratory will be used as a testing unit by the regulator.

5.2 ISO/IEC 17025

ISO/IEC 17025 is the International Standard that specifies the general requirements for the competence of laboratories to carry out tests and/or calibrations. This standard contains management requirements and technical requirements. It is applicable to all organisations performing tests and/or calibrations.

5.2.1 Introduction

As previously stated, ISO/IEC 17025 describes criteria that a quality management system in a laboratory should meet. However, several points of interest are mentioned which laboratories must assess critically. For example, laboratories must indicate how an operation is carried out every time it is done. The list of points of interest in the standard is not a static package that provides a pre-determined level of quality. It is a means of dynamically and continuously improving the level of quality in laboratories.
ISO/IEC 17025 is to be used as follows:

- To ensure that testing and calibration laboratories operate a quality system and that they have technical competence and generate technically valid results for testing and calibration;
- As the criteria for laboratory accreditation by the accreditation bodies;
- To confirm and recognise the competence of laboratories by their clients or regulators;
- To ensure that laboratories operate a quality system for their testing/calibration activities that also meet requirements of ISO 9000 series.

5.2.2 Requirements for Management and Organisation

ISO/IEC 17025 mentions a number of important management and organisational aspects that ensure the quality of the results of the tests and calibrations. The requirements also include a regular review to be carried out by the manage-

ment of the quality management system and evaluation of the test and/or calibration activities.
It is important to set up an independent laboratory, because the management and the personnel can be out of the influence of internal or external commercial, financial and other obligations that may affect the quality of the work.
As stated previously, the client plays an important part in the implementation of ISO/IEC 17025. The standard requires a system to handle complaints in addition to procedures (who does what) and work instructions (how something is done) on who informs the client and how the client is informed in tests and/or calibrations (subcontracting).

5.3 International Mutual Recognition

5.3.1 The Mutual Recognition of Laboratory Accreditation.

The laboratories of mutually recognised countries must be based on unified international standards, adopt the same operation mode, accept equivalent technology, require the market to accept the technique certificate from each mutually recognised country and require the government to admit the aspects of compelling rules of law.
A Mutual Recognition Arrangement (MRA) is an arrangement between two or more parties to mutually recognise or accept some or all aspects of one another's conformity assessment results (e.g. test reports, certificates of compliance). Through MRAs, products that are tested and/or certified before export can enter the importing country directly without having to undergo similar conformity assessment procedures in the importing country. (See also: Mutual recognition of national measurement standards and of calibration and measurement certificates. Paris, 14 October 1999.)
The mutual recognition of laboratory accreditation can be classified as local mutual recognition and international mutual recognition. Local mutual recognition includes the Europe Accreditation Cooperation (EA) and the Asia Pacific Laboratory Accreditation Cooperation (APLAC). The international mutual recognition organisation is the International Laboratory Accreditation Cooperation (ILAC).

5.3.2 The Qualifications for Mutual Recognition

No matter whether regional or international mutual recognition is carried out, reaching the mutual recognition agreement is the foundation of mutual recognition work. In the agreement, the accreditation institutes, no matter whether they belong to the government or individuals, are required to operate according to the ISO/IEC rules. Moreover, every accreditation institution must show that its operations are effective. In this way, it can ensure that the ability of a laboratory that it has accredited is in accordance with the ISO/IEC 17025 criteria. In order to achieve international mutual recognition, the metrological benchmark and the criterion of every country must be equivalent or accordant. The method in use is to compare the national metrological institutions of different countries. The key comparison is carried out by choosing the main physical quantities in a field. The national benchmark and the standard value of every country must be in accordance with the reference value fixed through the key comparison (representing the value of SI units). Indefinite equivalence is used to denote the metrological equivalence of each country's measurement standard. (See also: Mutual recognition of national measurement standards and of calibration and measurement certificates. Paris, 14 October 1999.)

5.3.3 The Benefits of Mutual Recognition

The ILAC mutual recognition agreement is an important cooperation tool that serves to promote international free trade. It stipulates that every participant who has signed the agreement must mutually accept the results of laboratory accreditation and accept the testing and calibration data represented by the accredited laboratory. That is the principle of 'one inspection/accreditation, global admission'. Thus, when products are sold from one country to another, there is no need to inspect them again. This promotes the international free traffic of goods by decreasing costs, minimising technical barriers and promoting the globalisation of trade.

6 Concluding Remarks

The aim of this lecture is to provide readers with some basic and important knowledge of metrology and related topics, such as standards, calibration, etc. By learning the basic definitions, the readers will have foundation knowledge for further study. By studying the basic features of standards and metrology, readers are expected to gain an insight into the international standards systems. It is also helpful for readers to understand the above-related knowledge if they are familiar with the role and structure of important institutions, such as BIPM, OIML and ILAC, etc. The reader who wishes to deepen his/her knowledge of metrology and standard topics may visit the next section ('Bibliography and Resources') as a starting point.

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Internet Resources

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BIPM website: www1.bipm.org/en/home/
Metrologia on-line: www1.bipm.org/metrologia/SearchResults.jsp
OIML website: www.oiml.org/index.html
ILAC website: www.ilac.org
PTB website: www.ptb.de/index_en.html
NIST website: www.nist.gov

8 Glossary

APEC-SCSC
The Asia-Pacific Economic Cooperation (APEC) Sub-Committee on Standards and Conformance (SCSC). A committee, which is responsible for coordinating the work of NSBs of the APEC members with the International Standards Organization.

APLAC
Asia Pacific Laboratory Accreditation Cooperation

CASCO
Committee on conformity assessment

- To study means of assessing the conformity of products, processes, services and management systems to appropriate standards or other technical specifications.
- To prepare international guides and International Standards relating to the practice of testing, inspection and certification of products, processes and services, and to the assessment of management systems, testing laboratories, inspection bodies, certification bodies, accreditation bodies and their operation and acceptance.
- To promote mutual recognition and acceptance of national and regional conformity assessment systems, and the appropriate use of International Standards for testing, inspection, certification, assessment and related purposes. ISO-CASCO, Committee on conformity assessment, www.iso.org.

COPOLCO
Committee on consumer policy

- To study means of helping consumers to benefit from standardisation, and means of improving consumer participation in national and international standardisation.
- To provide a forum for the exchange of information on the experience of consumer participation in the development and implementation of standards in the consumer field, and on other questions of interest to consumers in
- national and international standardisation.
- To advise ISO Council as to the consolidated viewpoints of consumers on matters relevant to ISO's current and potential standardisation and conformity assessment work.
- To advise ISO Council on the need for new or revised policies or actions within ISO as they relate to consumers' needs.

ISO-COPOLCO, Committee on consumer policy, www.iso.org, viewed on 1 May 2006.

FDI
Foreign Direct Investment
Direct investments in productive assets by a company incorporated in a foreign country, as opposed to investments in shares of local companies by foreign entities. An important feature of an increasingly globalised economic system.
Foreign Direct Investment, www.investorwords.com

ILAC
International Laboratory Accreditation Cooperation

ISO DEVCO
ISO - Committee on developing country matters

O member
Observer member in a technical committee of the International Organization for Standardization who would like to receive information on the related research and development of the technical committee.

P member
Participating member in a technical committee of an International Organization for Standardization who has the right to vote, receive information and participate in technical work.

SADC
Southern African Development Community

SPS
Sanitary and Phytosanitary Measures

TBT
Technical Barriers to Trade

TMB
Technical Management Board

UNIDO
United Nations Industrial Development Organization

Vietnam Star Project
STAR Project is funded and developed by the US Agency for International Development at the request of the Government of Vietnam in an effort to assist Vietnam in meeting the commitments of the US-Vietnam Bilateral Trade Agreement (BTA) and accede to the WTO.
VietnamStar Project, www.worldbank.org

9 Key questionss

- What do the SI base units include?
- What is a Mutual Recognition Arrangement (MRA)?
- What is traceability?
- What is metrology?
- What is legal metrology?
- What is a laboratory?
- What is the role of BIPM?
- What is a reference standard?
- What is 'laboratory accreditation'?
- What are the objectives of ISO/IEC 17025?

Mingshun Song · Hui Jiang · Tongyu Lu · Hongkuan Wu

Abstract

This lecture deals with quality management and its relation to the ISO 9000 standards, and includes a discussion of the concept of quality, some common quality management approaches, and ISO 9000 standards. Product quality is a key problem to which both producers and consumers pay much attention. It is said the 21st century is the quality century (J.M. Juran). Quality has become a key factor of competitiveness not only for enterprises but also for countries. Quality management principles mainly concern managing quality well and guaranteeing a product's persistent competitiveness in the international market. Therefore, this lecture is helpful to understand some essential approaches of quality management. Chapter 2 provides the phases of quality management development. Chapter 3 introduces the common statistical approaches and Total Quality Management. Chapter 4 provides the ISO 9000 family of standards and quality management system certification. A discussion of ISO 9000 quality management system certification in China is provided in Chapter 5. Concluding remarks are made in Chapter 6. Furthermore, readers are provided with references that will help them keep track of future developments in quality certification.

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1 Preface

Quality management assures that products are of high quality. In order to maintain an ongoing high grade of products, quality management approaches are continuously renewed and developed. Quality management enhances economic efficiency. It has developed from initial quality inspection to the present Six Sigma management (or 6σ), from the inside of enterprises to the outside of enterprises, and from improving only product quality to also focusing on customer satisfaction. With the development of global economic integration, translational cooperation is becoming more frequent, domestic and foreign markets are becoming more integrated and unified, and products are becoming more technical and complex. Because it is increasingly difficult for the average consumer to judge a product's quality, it has become the product supplier's responsibility to provide reliable products that conform to standards.

Thus, third party quality certification, such as ISO 9000 certification standards, has become a necessity. The ISO 9000 quality management standards provide quality management instruction for small and medium-sized enterprises, and supply a quality guarantee for consumers. At the same time, they play a positive role in promoting export markets in developing countries. But, ISO 9000 standards overemphasize universal application, which undermines their ability to assure quality. On the other hand, inappropriate application of ISO 9000 standards may create barriers for international trade. These are some of the new challenges that ISO 9000 standards are facing. Currently, there are many quality management approaches, but they are not necessarily interchangeable. Some traditional quality management approaches are not only important methods for effective quality management work, but are also the foundation for new quality management approaches. This unit will introduce and analyse the quality management issues outlined in this Preface.

2 The history of quality management

Growing gradually with production development and advances of science and technology, quality management has gone through four stages.

2.1 The inspection stage

Before World War II, people's understanding of quality was limited to quality inspection, which meant controlling and assuring product quality through rigorous inspection before the product was passed to the next process or was ready to be sold in the market. Inspection was the primary measure for quality management at this stage. Before the 20th century, the worker was both the operator and the inspector in workshops where products were made. This is so-called 'operator quality management'. In the early 20th century, F. W. Taylor, the founder of scientific management, advocated separating inspection from the production process. Thus, some factories set up a "master system" which executed product quality inspection. This system enhanced the function of quality inspection, and "master quality management" became a common practice. As science and technology developed and the scale of production increased, some factories established full-time inspection divisions and assigned full-time inspectors to check product quality. The function of quality inspection transferred from the master to the quality inspector, hence the term 'inspector quality management' (Song Mingshun, 2005, Quality Management, Science Press, Beijing). Today, inspectors examine and test product quality based on product standards and testing standards. Sampling testing is a common method used in quality inspection, and there are many sampling standards such as ISO 2859-1.2.3.4:1999.

2.2 Statistical process control (SPC)

The inspection stage, mentioned in section 2.1, is only a kind of ex-post inspection similar to a post-mortem examination and does not provide any preventive or control functions during the production process. In 1926, an American engineer named Walter Shewhart, from Bell Telephone Laboratories, introduced the concept of prior control to prevent defective products and invented the practical 'quality control chart' to solve deficiencies in the ex-post inspection. This 'quality control chart' was based on probability and statistical theory.

During World War II, owing to the huge demand for highly reliable military supplies, the American government and its defence department organized a group of statistics experts and technicians to research the quality and reliability

of military supplies. The group worked out three wartime quality control standards: the AWSZ 1.1-1941 quality control guide, the AWSZ 1.2-1941 data analysis control chart, and the AWSZ 1.3-1941 procedure control chart. The introduction and application of these standards indicated that quality management had entered the stage of statistical process control. Today, there are many standards related to statistical process control, such as ISO 7870:1993, ISO 8258:1991, and ISO/TR 10017:1999. These standards are mostly used in preventing and controlling quality defects (Song Mingshun, 2005, Quality Management, Science Press, Beijing).

2.3 The stage of Total Quality Management (TQM)

The American experts A.V. Feigenbaum and J.M. Juran introduced the concept of 'Total Quality Management' (TQM) at the beginning of the 1960s. In 1962, Feigenbaum published the book 'Total Quality Management'. This book proposed the following theories:

- satistical methods are not sufficient and therefore, quality management should also consider quality, price, delivery date, and service instead of just the narrow management quality concept;
- there exists a process of emergence, formation and realization, which requires quality management to implement integrated management in the whole process of quality formation instead of just stressing management in the production process;
- quality involves all the departments and staff in an enterprise, so all members should be conscious of and responsible for quality.

Total Quality Management marked a new stage of quality management that was more effective and complete. Total Quality Management played a very important role in the Japanese economic boom from 1960 to 1980. Japan's famous quality management expert, Professor Koaru Ishikawa, once said: 'Total Quality Management is a revolution in operation, and a new operation philosophy.' Current methods in TQM are diversified and flexible, but the ISO 9004:2000 standard can be cited as a guide for TQM (Song Mingshun, 2005, Quality Management, Science Press, Beijing).

2.4 The stage of quality assurance

By the end of the 1980s, quality assurance had become the mainstream approach in quality management. Quality management focuses on providing confidence that quality requirements will be fulfilled. As can be seen from the definition, the core of quality assurance is to provide customers and interested

parties with enough confidence to be convinced that the product, the process and the management system of the organization meet quality requirements. Quality assurance can be classified as internal and external depending on the purpose. The objective of internal assurance is to provide top management with confidence that the product, the process and the management system of the organization meet quality requirements. Internal quality assurance is guided by international standards. ISO 9001 and ISO 9004 are examples of important international standards for an internal quality assurance system. Internal quality assurance is called first party certification.
External assurance refers to the customer's confidence; and there are two ways to acquire this. The first is that the organization accepts quality management examination by the customer. The customer audits the organization's quality management system in terms of some international standards such as ISO 9001. This type of external assurance is called second-party certification. The second party is the customer. The second method of acquiring the customer's confidence is to have a third-party inspect and/or audit the products and/or the quality management system independently and fairly. The third party is the intermediary service enterprise for product quality or/and quality management system certification and registration. If the organization is proven to conform to requirements specified by product standards or quality management standards, the third party issues a certificate to the organization. The certificate verifies that the quality management system and product quality are under systematic control. ISO 9001 is the most widely used international standard among all the international quality assurance standards (Song Mingshun, 2005, Quality Management, Science Press, Beijing).

3 Common quality management approaches

3.1 Introduction

There are many quality management methods, such as:

- product quality inspection that includes sampling testing, measurement conformity system certification based on ISO 10012 standards, laboratory quality management system accreditation according to ISO/IEC 17025 standards;
- statistical process control that includes the cause-effect diagram, the Pareto chart, the histogram, the control chart and so on; Total Quality Management that includes the PDCA cycle, quality cycle group, and zero-defect theory;
- quality assurance that includes product quality certification and quality management system certification; the customer satisfaction index; Six sigma management, etc.

Each approach has its own features and can be applied properly based on both these features and the organizational situation. In this chapter, common statistical process control tools and Total Quality Management are introduced.

3.2 Statistical process control (SPC)

3.2.1 Introduction

As a science, quality management has developed through at least four stages. Due to the technology and methodology used when solving quality problems, later stages are based on earlier ones. Therefore, statistical quality control technology is also used in Total Quality Management, quality assurance and others. The cause-effect diagram, the Pareto chart, the histogram, and the control chart are the most commonly used methods in SPC and are introduced briefly as follows:

3.2.2 The cause-effect diagram

Introduction

The cause-effect diagram shows the relation between cause and effect. It uses effect as the characteristic, takes cause as the factor, and connects them by an arrowhead. It is also called the characteristic and primary factor chart, the branch chart or the fish-bone chart. Koaru Ishikawa, a Japanese quality management scholar, designed the cause-effect diagram in 1943. The cause-effect diagram uses the theory of brainstorming, draws on collective wisdom, and looks for the underlying factors which influence quality. It starts with examining the factors that cause quality problems. The first step is to find the main factors, then find the secondary factors, and continue step by step until the key reason for the problem is found.

Methodology of the cause-effect diagram

The following example discusses in detail the use of the cause-effect diagram method. The quality of a photocopy is not up to the required standard. The cause-effect diagram is used to find the reasons for the blurred copy so that countermeasures can be taken and the problem can be solved.

The first step confirms that the quality problem needs to be analysed. The problem is described in the right pane, and a trunk is drawn with arrows to the right. To confirm that the blurred copy is the problem, a wide arrow is drawn from left to right.

The second step confirms the classification of factors that influence quality. Generally, we analyse copy quality problems according to five influencing factors: personnel, machine, material, method and environment. Reasons for

blurred copies are classified into personnel, copy machine, copy paper, ink containers, quality of the original, and duplicating methods. These are shown by the medium arrow.

The third step develops each classified item. Every medium branch shows a reason that causes quality problems in that item. The medium branches are drawn parallel to the trunk with arrows to the large branches. Reasons are written above or below medium branches.

The fourth step analyses the factors shown by each medium branch and finds the reasons that cause poor quality. It classifies the factors step by step and shows them by arrows of different width and length until the key reason for the problem is found.

The cause-effect diagram

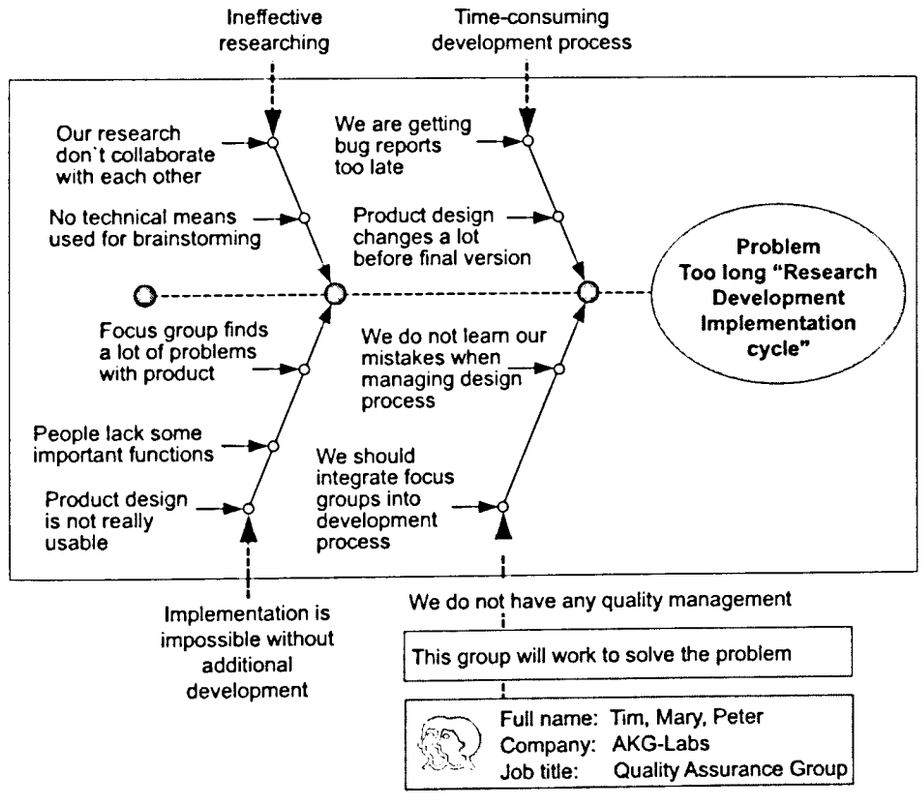


Figure: The cause-effect diagram (Source: www.mind-pad.com)

The fifth step checks whether or not any reason has been left out. From this, the primary reasons are indicated by rectangles on the chart. The sixth step indicates such information as the chart name, designers, drawing time and department. (See also: DOUGLAS, C. MONTGOMERY, 1991. Introduction to Statistical Quality Control. John Wiley & Sons, New York)

3.2.3 The Pareto chart

Introduction
The Pareto chart is also called the analysis chart of primary and secondary factors that affect quality. It is a simple graphic presentation technique used to arrange the factors from the most important to the least important. The Pareto chart is based on the Pareto theory, which was developed by a group of Italian economists in the 19th century when they analysed the distribution of the wealth of society according to the following formula: 80% of national wealth is controlled by 20% of the people. This 80%-20% relations is called the Pareto theory.

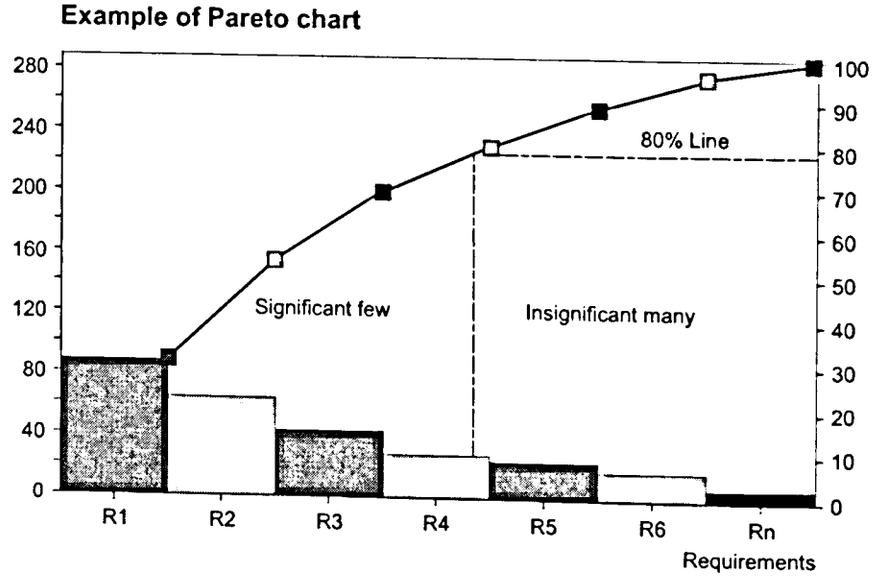


Figure: Form of Pareto chart (Source: www.mnl.com)

An American quality management expert named J.M. Juran applied the Pareto theory to quality management. He found that though many factors influence product quality, there are some key factors that contribute to the production of the greatest number of defective products. The Pareto chart in quality management arranges product quality data by category and uses a graph to show the key factors that affect product quality. It can then be seen which factor has the biggest influence on quality and what is the most efficient and beneficial way to improve quality.

Methodology of the Pareto chart
The Pareto chart is made up of two vertical coordinates, one horizontal coordinate, several histograms and one curve. The left ordinate represents frequency, the right ordinate represents the accumulated percentage, and the horizontal ordinate represents all the factors that affect product quality. These factors are arranged from left to right in order of influence. The height of the rectangle shows the greatest influence of some factors. The curve shows the accumulated percentage of the influence of all factors and is known as the Pareto curve. Usually the accumulated percentages are divided into three classes. Factors belonging to class 'A' whose accumulated percentages are below 80% are, of course, the primary ones. The factors belonging to class 'B', whose accumulated percentages are between 80% and 90%, are secondary ones. The factors belonging to class 'C', whose accumulated percentages are between 90% and 100%, are the most common ones (See also: DOUGLAS, C. MONTGOMERY, 1991. Introduction to Statistical Quality Control. John Wiley & Sons, New York).

3.2.4 The histogram

The concept of the histogram
The histogram is also called the quality distribution chart. It is a useful tool for judging and forecasting product quality during production through the analysis of measured data. The method of the histogram is applicable in processing large amounts of data. By seeking statistical theorems and analysing the distribution shape of data, the distribution character of the population can be estimated. The basic shape of the histogram is a number of rectangles arranged in order in the right angle of the coordinate system. The equal span of the bottom of each rectangle is called the data interval, and the height of each rectangle denotes the frequency of data located in the interval. In practice, although the measured data are different in meaning and type, they have the same basic characteristics: the property of scatter. This property is caused by the differences in the product quality, the variety of conditions in the process of production and other sorts of errors. Even though conditions are the same, with the same material and strict operation controls, production data will not be identical. This is only one facet of the characteristics of the data. In

addition to this, if the data are sufficient and are properly collected, they will present some statistical features. The best way to find these features is to draw a histogram of the data. The histogram shows the distribution, the mean level and the degree of scatter of the product's quality. With this information it is possible to judge whether the production process is stable or not, analyse the factors that influence product quality, predict the rate of unqualified products, and give suggestions for quality improvement.

The steps of constructing the histogram and analyses
The steps of drawing the histogram can be broken down as follows: collecting data, finding the maximum and minimum in the data and calculating the range, confirming the width of the class and the number of the class, confirming the bound value of the class, calculating the middle value of every class, counting the frequencies of every class, and drawing the picture of the histogram. The histogram reflects the distribution of product quality more visually and clearly than other methods. It is important to pay attention to the shape of the whole graph when observing the histogram. The shape determines whether the histogram is normal or abnormal. If it is an abnormal shape, the standard shape patterns are used to determine which type it is. The reasons for the quality problems can be analysed and proper measures to correct them can be taken.

The histogramm

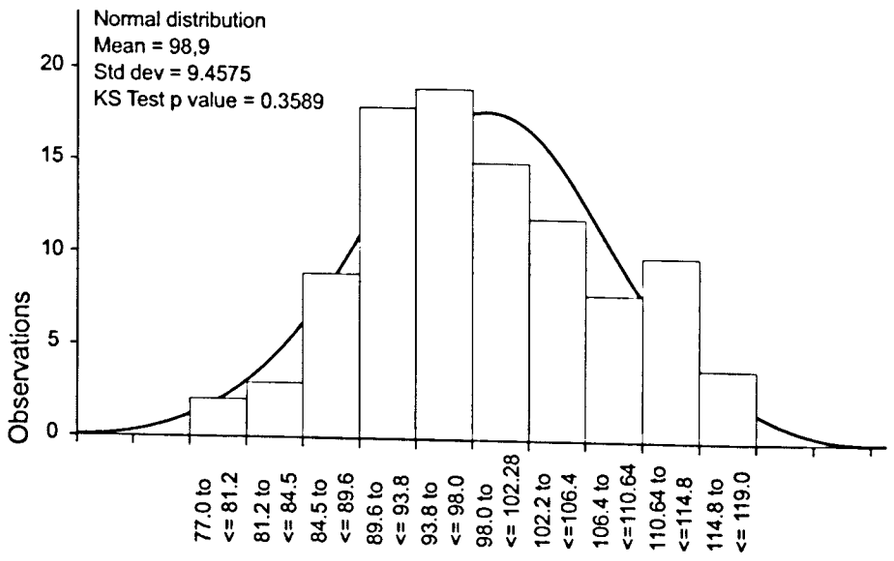


Figure: The histogramm (Source: www.sigmazone.com)

There are eight types of standard shape patterns of the histogram (See also: EUGENE L. GRANT, RICHARD S. LEAVENWORTH, 1980. Statistical Quality Control, McGraw-Hill, New York).

3.2.5 The control chart

Introduction
SPC is the abbreviation for Statistical Process Control. SPC is used to supervise each stage of a process by applying statistical technology so as to improve and assure quality. Control chart theory is the most important statistical technology of SPC. The control chart shows whether or not the production procedure is under control. Using this method, it is possible to diagnose whether quality fluctuation is caused by random factors or systematic factors. In 1924, an American quality expert, W.A. Sheuhart, was the first to use the control chart to control process quality and prevent product defects. As a result, the common control chart is called the Sheuhart control chart.

How to draw a control chart
The control chart uses data collected in approximately equal intervals during a process. The intervals can be defined by time (such as hour) or by quantity (such as batch). Usually, data selected in this way are called a subgroup in a process control, and each subgroup is of the same size. One or more subgroup characteristics are derived from each subgroup, such as mean, subgroup range R, or standard deviation S of a subgroup. There are two control limit lines and one central line in the common control chart.

In the Figure, the abscissa is the sample group number (subgroup number) arranged by time, and the y-axis is the quality characteristic value or sample statistical value. The two control limit lines are usually shown as dashed lines. The upper one is the UCL (Upper Control Limit), the lower one is the LCL (Lower Control Limit), and the central line is shown in a continuous line (marked as CL, Central Line). In the production process, samples should be taken at certain times and the measured dots are drawn on the graph paper by time. If dots are located between the two control limit lines and their scatter is random, it means that the production process is under control, and it is not necessary to intervene in production. If dots are beyond the two control limit lines or their distribution between the two control limit lines is not random, it means that the production process is not under control and some controlling measures should be taken. Thus, the control chart can be used to continuously supervise the production process in order to produce warning signals when systemic problems appear and thus to implement preventive measures.

Statistical principles of the control chart

In the production process, if only random factors exist, the product quality characteristic value X will form some determinately typical distribution, such as a normal distribution. If systemic factors appear, X will deviate from the original typical distribution. The hypothesis testing method in statistics can be used to find this kind of distribution deviation over time. In most cases, X follows a normal distribution, that is X-N(μ,σ2); μ is the expectation of X, and σ2 is the variance of X. If the production process does not have systemic factors, then the probability P(μ-3σ<X <μ+3σ) is equal to 99.73%. The sum of the probability that X locates beyond the two dashed lines is only 0.27%. That means there are an average of 3 dots located outside (μ-3σ, μ+3σ) in the sample size of 1,000.

If only one sample of X is taken from the production process, it is impossible for the sample to be located beyond (μ-3σ, μ+3σ). This is the 3σ principle.

Generally speaking, in light of the 3σ principle, if the sample appears beyond the distribution range μ±3σ, it is assumed that the production process is not under control. Customarily, μ-3σ is taken as the LCL, μ+3σ as the UCL, and μ as CL.

There are many types of control charts. When classified by statistical quantity, they can be divided into measure control charts and count control charts.

Demonstration of the control chart

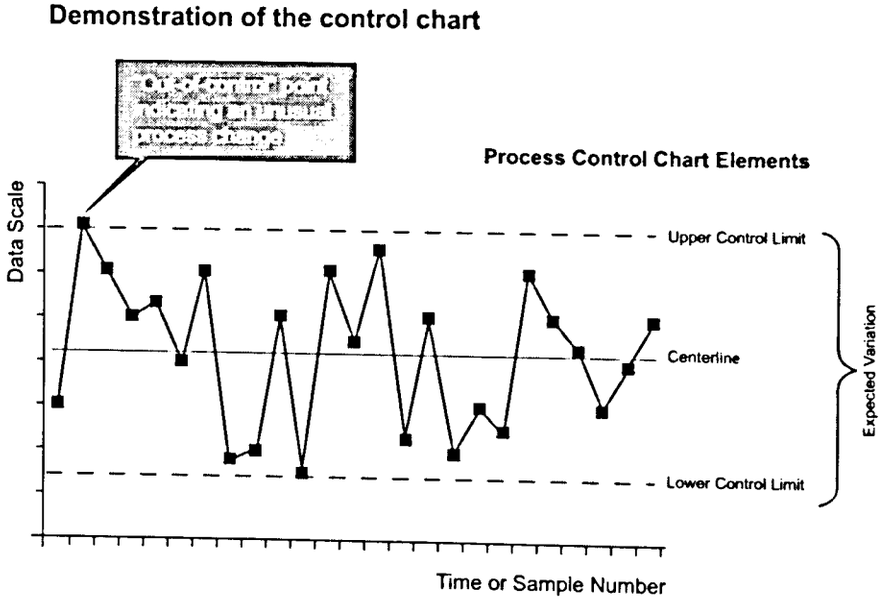


Figure: Demonstration of the Control chart (Source: www.wintl.com)

Common measure control charts include the following types:

- mean value and range charts, namely –R chart;
- mean value and standard deviation control chart, namely –S chart;
- median and range charts, namely Me–R chart;
- single chart and mobile range control charts, namely X–Rs chart.

Common count control charts include the following types:

- rejection percentage control chart, namely P chart;
- rejection quantity control chart, namely Pn chart;
- objection quantity control chart, namely C chart;
- objection quantity per product control chart, namely U chart
- (See also: DOUGLAS, C. MONTGOMERY, 1991. Introduction to Statistical Quality Control. John Wiley & Sons, New York).

3.3 Total Quality Management (TQM)

3.3.1 Introduction

Total Quality Management (TQM) includes scientific analysis, synthesis, abstract, and summary of the essential contents of quality management. These explore the objective regularity of quality control in order to provide guidance in conducting quality management according to objective laws. TQM is a management approach that provides long-term success based on the participation of all members. Quality is regarded as the core issue of any

Business Excellence Model

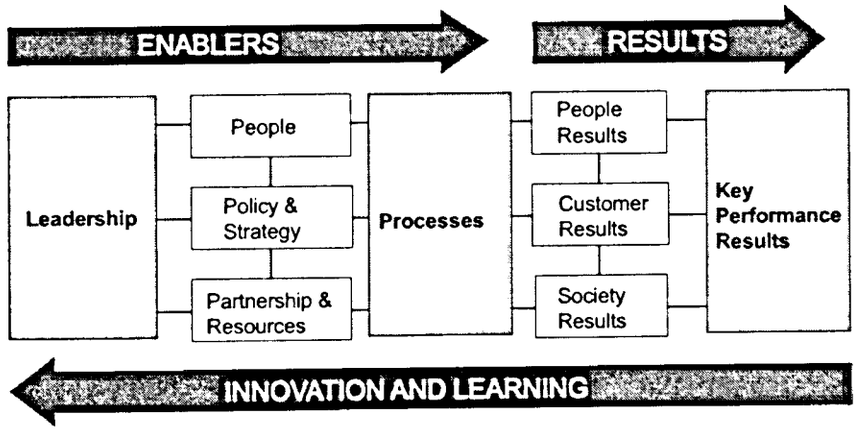


Figure: TQM model (Source: www.batalas.co.uk)

organization, and is beneficial for customers, members of the organization and society in general.
Total Quality Management (TQM) includes scientific analysis, synthesis, abstract, and summary of the essential contents of quality management. These explore the objective regularity of quality control in order to provide guidance in conducting quality management according to objective laws.

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3.3.2 The principles of TQM

Traditional quality management states that quality management is the responsibility of the production division and the quality inspection department that focuses on management of the production process and product quality inspection. TQM focuses on the key word "the whole".

Overall quality management
The goal of quality management is to meet the requirements of users who expect satisfactory and low-cost goods, on-time delivery, and reliable customer service. The concept of 'quality', which was originally confined to product quality, has been broadened into a more comprehensive concept of quality. 'Quality' in TQM is a broadly defined concept. It not only includes general product quality characteristics but also performance and service quality. Therefore, TQM is the quality management of products, projects, performance, and service.

Quality management of the whole process
The whole process refers to product design, manufacture, and sale. Quality management of the whole process means managing each relevant process according to the quality concepts mentioned above. Quality management in the design process includes all phases from market survey, design, and trial production. This process is important for product quality. Quality management in the manufacturing process includes all quality checking and controlling from the time that raw materials enter the factory to the final dispatch of the finished product.
Quality management of the sales process includes technological support and collecting user suggestions and feedback, which is beneficial for improving the design and the manufacturing approaches in a timely fashion.

Quality management of all employees
Product quality is the reflection of performance quality. Every department, workshop and staff member of an enterprise influence the quality of products directly or indirectly. So another important characteristic of TQM is the requirement for all the personnel of an enterprise to be responsible for improving performance quality to assure reliable product quality. The quality circle (QC group) is the most important organization to mobilize and organize the staff to improve and assure product quality actively during the entire process.
Quality management is everybody's duty. Every staff member and manager should study and use scientific theory and quality methods to improve performance quality.

A variety of quality management methods
The methods adopted in quality management are comprehensive, varied, and include administrative skills and scientific methods. Advanced scientific, technological and management methods should be used consciously in quality management. SPC, the common method applied in TQM, includes many useful statistical methods, such as the Pareto chart, the cause-effect picture, the histogram, the control chart, regression analysis, etc. These methods are used to analyse the performance quality of the department, to find out existing product quality problems and to determine the key factors influencing quality. Thus the quality of the production process can be controlled effectively in order to achieve the goal of improving product quality.

3.3.3 The procedure of TQM

The procedure of TQM requires a set of operational procedures and concrete guidelines for production. TQM uses a set of scientific and logical operational procedures, namely the 'P, D, C, A' cycle. 'PDCA' consists of the first letters of 'Plan, Do, Check and Action': The concept of the 'PDCA' cycle was first put forward by W. E. Deming, an internationally-known expert on quality management, and therefore it is called the 'Deming Cycle'. As the basic approach to TQM, the 'PDCA' cycle divides the process of TQM into four stages, namely 'plan, do, check and action'.

The four stages of the 'PDCA' cycle
The 'Plan' stage: draft the quality plan after investigating product and service quality factors. The 'plan' stage aims at satisfying the customer's requirements and the enterprise's economic benefits. The plan outlines the objectives of quality, the processes, the projects for implementation, etc. The 'Do' stage: make efforts to implement and realize the goals and tasks of the plan, i.e., the plan is put into action. The 'Check' stage: check the activities and results against the requirements of the plan. In this stage, it becomes clear which measures are effective and which are not, what constitutes a successful

experience and which lessons are learned from the failures. The 'Action' stage: take action to consolidate achievements and draw lessons from the results so that improvements can be made in the future.

Characteristics of the 'PDCA' Cycle

The 'PDCA' cycle has two characteristics as follows:

A big cycle includes many small cycles. If the whole enterprise is compared to a big PDCA cycle, then each workshop, team, or functional department has its respective small PDCA cycles. They promote each other, and small cycles assure the big ones. The 'PDCA' cycle is not only suitable for the entire enterprise but also for each workshop, administrative office, team and individual. Departments at various levels should have their own objectives and PDCA cycles in accordance with the principles and goals of the whole enterprise. By doing this, the big cycles include small ones, and the small cycles include even smaller ones. The whole enterprise is a big PDCA cycle, each department has its respective PDCA cycle, and everyone has their individual PDCA cycle. Various jobs of the enterprise can be connected, coordinated and promoted organically through cycles.

The continuous running cycle rises like a ladder. The four stages should move in cycles. It can be seen from the Figure that the 'PDCA' cycle does not stay on the same level. Some problems will be settled and some achievements will be gained in one cycle. Therefore the 'PDCA' cycle will move forward with new contents and objectives. It will step to a higher level and the quality will have

A big cycle includes small cycles

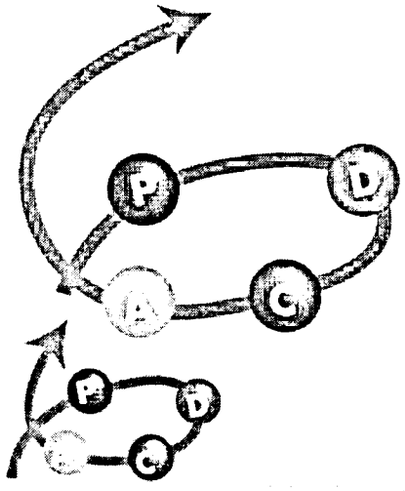


Figure: A big cycle includes small cycles (Source: www.chikousaikir.jp)

new improvements, similar to climbing stairs. After each stage of a cycle, the level will reach a new height and then rise step by step.

3.3.4 Quality cycle group (QC)

The most effective organization for pursuing TQM is to set up various groups of quality control (herein called 'QC' groups, which is the abbreviation of 'Quality Control' or 'Quality Circle'). TQM requires all members to take part in quality management. Through developing various forms of mass quality management campaigns, especially developing quality management group campaigns, every employee's intelligence and wisdom is fully brought into play, and a lively environment with full participation in QC activities is easily formed. This is an effective way for an enterprise to raise the management level, improve employee behaviour, promote the development of cultural and ideological progress, and solve quality problems. The QC group originated in Japan. From the late 1950s to the early 1960s, Japanese enterprises gradually paid more attention to statistical technology and trained their employees in using these principles. In order to further improve technology and product quality, the QC group was ingeniously devised by combining methods of target management and incentive management with the unique corporate culture of Japanese enterprises. In Japan, QC was popular in all trades and made great contributions to the Japanese economic boom (See: Song Mingshun, 2005, Quality Management, Science Press, Beijing).

4 The ISO 9000 family of standards

The ISO 9000 family of standards refers to a group of international standards made by the Quality Management and Quality Assurance Technical Committee (ISO/TC 176) of the International Organization for Standardization. (ISO).

4.1 Introduction

The ISO 9000 family of standards is a set of quality management and quality assurance standards (not product standards). These standards can help organizations implement and run quality management systems effectively, and they are interchangeable requirements and guidelines for setting up quality management systems. The ISO 9000 family of standards, primarily concerned with 'quality management', has become an international reference for quality management requirements in business-to-business dealings.

The organizations adopting these standards should fulfill:
- the customer's quality requirements, and
- applicable regulatory requirements, while aiming to
- enhance customer satisfaction, and
- achieve continual performance improvement in pursuit of these objectives.

4.1.1 The relationship between TQM and ISO 9000 standards

ISO 9000 standards and TQM have a close relationship and share many quality management principles and rules, as follows:
TQM stresses the important role of leadership in the process of quality management, and is also called the Top-level Quality Management. ISO 9000 standards also emphasize senior management responsibility. In ISO 9001, top management must provide evidence of its commitment to the development and implementation of the quality management system and to continually improving its effectiveness. Total process management is one of the most important approaches in TQM, and the PDCA circle is the main method in the total process approach. ISO 9001 promotes the adoption of a process approach when developing, implementing and improving the effectiveness of a quality management system. This enhances customer satisfaction by meeting customer requirements, and also ensures that the methodology known as 'Plan-Do-Check-Act' (PDCA) can be applied to all processes.

The principles of prevention, customer focus and continual improvement have been adopted not only in TQM but also in ISO 9001. The main methodology in TQM is SPC, which includes the cause-effect diagram, the Pareto chart, the histogram, and the control chart, etc. SPC is also adopted in ISO 9001, particularly in item eight, 'Measurement, analysis and improvement' of ISO 9001. TQM is appropriate for internal quality management, but there is no unified model in use. ISO 9000 standards have been developed on the basis of TQM. In ISO 9000 standards, there are many standardized methods of TQM. ISO 9000 standards can be used by internal and external parties, including certification bodies, to assess the organization's ability to meet customer, regulatory and its own requirements.

4.1.2 History

The first civilian quality system standard was BS 5750:1979. As the need for cross-border transparency and harmonized global quality standards increased, the ISO formed a technical committee, TC 176, to draw up a series of international standards for quality management. The first edition of the ISO 9000 series of standards came out in 1987. It was revised in 1994, and then an updated version was republished in 2000. This version of the standards is referred

The ISO 9000 standards family

ISO9000: 2005	Quality management systems - Fundamentals and vocabulary
ISO9001: 2000	Quality management systems - Requirements
ISO9004: 2000	Quality management systems - Guidelines for performance and improvements
ISO10002: 2004	Quality management - Customer satisfaction - Guidelines for complaints handling in organizations
ISO10005: 2005	Quality management systems - Guidelines for quality plans
ISO10006: 2003	Quality management systems - Guidelines for management in projects
ISO10007: 2003	Quality management systems - Guidelines for configuration management
ISO19011: 2002	Guidelines for quality and/or environmental management system auditing
ISO10012: 2003	Measurement management systems - Requirements for measurement processes and measuring equipment
ISO/TR10013: 2001	Guidelines for quality management system documentation
ISO/TR10014: 1998	Guidelines for managing the economics of quality
ISO10015: 1999	Quality management - Guidelines for training
ISO10017: 2003	Guidance on statistical techniques for ISO 9001:2000
ISO10019: 2005	Guidelines for the selection of quality management system consultants and use of their services

Figure: The ISO 9000 family of standards (© Song)

to as the 'ISO 9000:2000 family of standards'. The ISO 9000:2000 family of standards is currently applicable while the ISO 9000:1987 series of standards and the main standards of the ISO 9000:1994 family of standards have been abolished.

4.1.3 The ISO 9000:1987 series of standards

The ISO 8402 standard was issued in 1986, and the ISO 9000, ISO 9001, ISO 9002, ISO 9003 and ISO 9004 standards were published in 1987. This set of standards plays a positive role in standardizing quality management and developing international trade.

4.1.4 The ISO 9000:1994 family of standards

Because the ISO 9000 family of standards is mainly suitable for the manufacturing industry, ISO/TC 176 revised parts of the ISO 9000 family of standards and added the ISO 10000 family of standards as supplementary standards of the ISO 9000 family. These standards formed the ISO 9000 family of standards of the 1994 edition. There are 22 standards and 2 technological reports altogether in the ISO 9000 family of standards.

4.1.5 The ISO 9000:2000 family of standards

Despite being used worldwide, the ISO 9000:1994 family of standards was found to be insufficient. On the basis of investigation, the ISO made modifications to such areas as ensemble architecture and technological contents of this set of standards and issued the 2000 edition of the ISO 9000 family of standards in December 2000. There are four main standards in the 2000 edition of the ISO 9000 family of standards at present. The ISO combined them with other existing standards or released and published them in the form of technological reports (TR), technical specifications (TS) or brochures. Technical reports, technical specifications and brochures are guidance files for setting up and operating quality management systems. The figures of the ISO 9000 family of standards of the 2000 edition are as follows:

The main standards of the ISO 9000:2000 family of standards

ISO 9001:2000	Quality management systems - Fundamentals and Vocabulary
ISO 9001:2000	Quality management systems - Requirements
ISO 9004:2000	Quality management systems - Guidelines for performance and improvements
ISO 19011:2002	Guidelines for quality and/or environmental management systems auditing

Figure: The main standards of the ISO 9000:2000 family of standards (© Song)

In the 2000 edition, the ISO 9000 family of standards mainly includes ISO 9000, ISO 9001, ISO 9004 and ISO 19011 standards which form a group of quality management system standards that can help organizations of different type and scale to implement and operate effective quality management systems.

4.2 ISO 9001:2000

ISO 9001:2000 replaced the ISO 9001, ISO 9002 and ISO 9003 standards of the 1994 edition and became the only standard of quality management system requirements applied in third-party certification.

4.2.1 The features of ISO 9001:2000

The ISO 9001:2000 standard, as one member of the ISO 9000 family of standards, stipulates quality management system requirements. It offers minimum requirements for quality management systems of an organization, ranging from management responsibilities, supplying resources, product realization, measurement analyses, and continual improvement. Its purpose is to satisfy customer requirements and applicable regulations. ISO 9001 can be applied to many types of organizations regardless of size or function. It can help both product-oriented and service-oriented organizations achieve standards of quality. This standard provides common guidelines and is not only suitable for many trade and economic fields, but also for products of any type.

This standard adopts quality management system modes based on process management and customer satisfaction. The requirements of process management are as follows:

- to discern the processes of quality management systems in organizations;
- to confirm the relationships between different processes;
- to confirm the criteria and methods that guarantee effective operation and control of the process;
- to guarantee essential resources and information in order to support operations and monitor the process;
- to monitor, measure and analyse the process;
- to implement the requisite measures in order to realize lasting improvement to the result and the process.

4.2.2 The main contents of ISO 9001:2000

There are eight parts in ISO 9001:2000 with two annexes: Tab A, 'correspondence between ISO 9001:2000 and ISO 14001:1996' and Tab B, 'correspondence between ISO 9001:2000 and ISO 9001:1994'. The last component is a 'bibliography' which gives readers guidelines and references to ISO 9001:2000. The main contents of this standard are listed in the following figure (See: http://www.iso.org).

The main contents of ISO 9001:2000

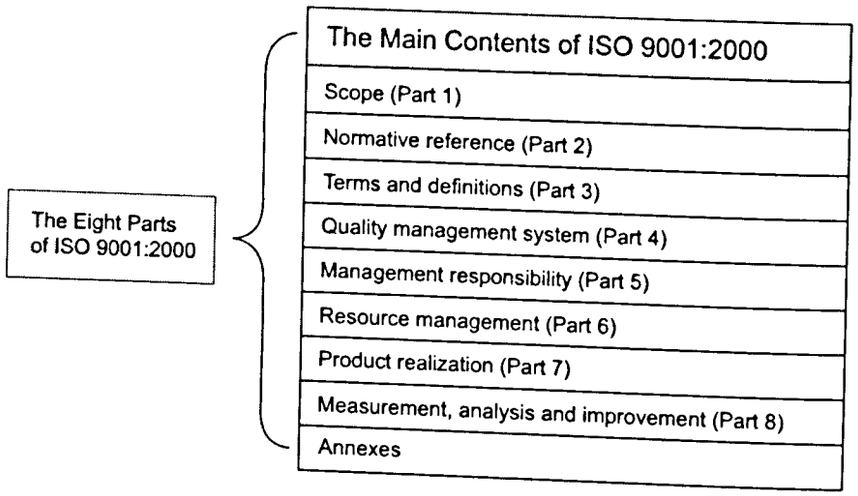


Figure: The main contents of ISO 9001:2000 (© Song)

4.3 Quality management system certification

4.3.1 Quality management system

A quality management system (QMS), according to the ISO 9000:2000 standards, refers to the system that controls and manages the quality of an organization. The management system refers to the systems that are set up to establish policies and goals and realize these goals. The quality management system is one part of the management systems of an organization. ISO 9001:2000 'Quality Management System Requirements' specifies the requirements for quality management systems. It establishes quality policies and objectives, and determines the related organizational structures, processes, activities and resources in order to achieve quality policies and objectives. The quality management system is composed of management responsibility, resource management, product realization and measurement, analysis and improvement. It aims to satisfy customers by meeting the requirements of customers and applicable laws and regulations.

Any organization that establishes QMS with ISO 9001 standards must specify the following activities and requirements and ensure their effective execution:

- identify the processes required for QMS and their applications in organizations;
- decide the order and reciprocity of these processes;
- determine the rules and approaches that assure the processes will be executed and controlled effectively;
- supervise, measure and analyse the processes;
- take necessary actions to fulfill planned results and achieve continuous improvements to the processes.

The ISO 9001 standard requires organizations to create documents relevant to quality management systems. The quality management system documents should be concerned with the whole or partial activities of the organization, and should include the following five types of documents as a minimum:

- the quality policies and objectives;
- the quality manual;
- the procedure documents;
- the quality records required by the standards.

The quality manual

Organizations must compile and maintain the quality manual according to ISO 9000 standards requirements. The contents of the quality manual should include, as a minimum: the scope of the quality management system, the documented procedures required for the QMS, the processes of the QMS and the description of their mutual relationship.

The procedure documents
A procedure is the specified approach to carry out some activity or process. Each documented procedure must answer the 5W1H questions, namely: why, what, who, when, where and how.

The records
The records are files that record the achieved results or supply the evidence for fulfilled activities. In order to meet the requirements and supply evidence for QMS operation, organizations must take records, and then must maintain and control them (See: Song Mingshun, 2005, Quality Management, Science Press, Beijing).

4.3.2 Quality management system certification

ISO/IEC Guidance 2:1991 defines certification as the third party giving a formal assurance to a product, process or service that meets the specific requirements. ISO 9001 QMS certification, according to ISO 9001 standards and QMS documents, follows the auditing procedures prescribed by the ISO 19011 standard and gives written guarantees to the organization whose QMS meets the specific requirements.

The following are the procedures for QMS certification:

Application
Following specific contents and formats, applicants (such as enterprises) formally apply to a QMS certification body and provide the quality manual and other necessary information. The QMS certification body handles the application, and may accept, refuse, or request a revised application depending on the situation. To accept an applicant, the body signs a certification contract with the applicant or its client and both sides are responsible for the contract.

Quality system audit
The auditors check the documents, and then perform an on-the-spot audit of the practical quality system of the applicant. The main objective is to check whether the quality manual submitted by the applicant meets the requirements of the quality system standard. If it doesn't conform to the requirements, the audit team requests that the applicant clarify, create, or modify the quality system documents. Once the documents meet requirements, the on-site audit can be started. The aim of on-site auditing is to determine whether the running of quality systems is consistent with the specifications of the quality manual. This is done by collecting objective evidence, proving conformity to the requirements of quality system standards and making an auditing conclusion. The formal members of the auditing team must be registered auditors, and one of

them must be a chief auditor. If necessary, technical experts may be employed to assist in the audit.

Corrective action
The applicant must plan the correction of any non-conformity and report to the certification body. The applicant must complete the correction and report the results of the correction within three months. If necessary, the certification body will recheck the effect of the correction on-site.

Submission of auditing reports and deliberation
The leader of an auditing team is responsible for the auditing report. The report must be submitted to the technical committee of the certification body and must be approved within a week. If the report is approved, it must be sent to the applicant or the client. A duplicate report and other materials are kept in the certification body as a record.

The audit process

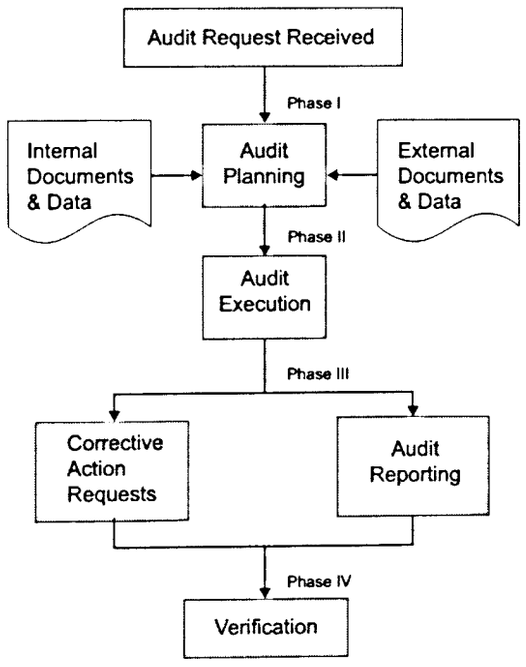


Figure: The audit process (Source: www.qualsat.com/materials © QualSAT)

Issues and publication
After deliberation and approval by the technical committee, a certificate of quality system certification is issued to the applicant. The applicant is permitted to utilize the certificate within the scope specified by the technical committee.

Supervision and management
The quality system certification body supervises and audits the certificate holder. If the quality management system of the holder is substantiated to comply with the specific requirement, the holder is qualified to retain the certificate. Otherwise, the certification body will prohibit the use of the certification mark temporarily or withdraw the certification qualification (See: www.cnca.gov.cn).

4.3.3 The roles of certification

The roles of certification are as follows:

Expanding market share
With an ISO 9000 certificate, the quality management system of the company is generally assured. To the customers, the certificate mark is a sign of confidence in the product. Therefore, the certificate is very useful to gain additional market share for the company.

Increasing profits
Well-defined written quality procedures will reduce chaos and improve operational flow for the organization. Quality management system certification can reduce the number of defective products, waste, inspection costs, reworking costs, and warranty costs due to reshipment and additional employee handling. It also provides training opportunities for employees to gain knowledge and new skills. As a result, net growth in the company profits will increase and the company will achieve substantial growth in the future.

Improving the management level
The management level of the organization will be improved through implementing the ISO 9001 standard and certification. Management policies, missions, goals and strategies of the organization can be achieved through quality management system certification.

5 The ISO 9000 family of standards in China

5.1 Introduction

The China National Accreditation Board for Certificates (CNAB) was set up in April 1994 and officially authorized by the Chinese government. CNAB is in charge of the unified management of conformity assessment activities. By the end of 2004, the number of certificates issued was 132,926. China has many small and medium-sized enterprises that lacked quality management methods in the past. Through quality system certification, most of them have improved their quality management and assured their product quality. Thus, their market competitiveness and economic benefits have increased. The results of a sampling survey from 142 registered companies that obtained ISO 9001 certificates three years ago is discussed in the following (See: www.cnca.gov.cn).

5.1.1 Product quality improved

The companies that implemented ISO 9001 quality system certification kept their product quality stable. Statistical data from 142 registered companies indicates that the average level of product quality conformity has increased by 4.68% since implementation of the ISO 9001 standard.

5.1.2 Economic benefits increased

Quality management system certification leads to a reduced number of defects and quality failures. As a result, product costs are reduced. An appropriate management structure is established, and the economic benefits for the company are increased. Accordingly, the survey indicated that 73.99% of respondents saw a reduction in the costs related to quality
(See: www.cnca.gov.cn).

5.1.3 Management level enhanced

By implementing quality management system certification, the quality awareness of managers and employees is increased. Internal audits and management reviews enhance a company's ability to identify and rectify problems and maintain an efficient operational quality system. From the survey, 93.7% of respondents witnessed a marked improvement in quality awareness throughout the process of quality system certification, and 96.5% of respondents improved the work quality of their personnel.

5.1.4 Competitiveness strengthened

The objective of any company in China is to gain a larger market share, and in particular, to achieve greater success in the international market, through ISO 9001 quality management system certification. Many companies in China consider that ISO 9001 certificate is a 'ticket' to entry into the export market. With ISO certification, 64% of the companies witnessed a growth in their domestic market share and achieved greater success in the international market. Another 24.6% reported fewer obstacles in landing sales agreements and contracts. A linear correlation analysis of the relationship between export volume and the number of certificated companies in China shows a significant positive correlation. It indicates that ISO 9001 quality management system certification plays an important role in increasing the export volume of Chinese companies.

5.2 Problems of quality system certification in China

Although economic benefits have been gained through ISO 9001 quality management system certification, problems have also been caused by implementation of the ISO 9001 standards. These problems are discussed in 5.2.1 and 5.2.2.

5.2.1 Misunderstanding about the role of certification

Many Chinese small and medium-sized enterprises believe that ISO 9001 quality management system certification is necessary to enter the international market. They may be misled by consultancy groups and certification bodies. As a result, they believe that only the products with the certificate mark are entitled to be exported. The certification appears to be only for exportation, and does not assure quality management. Many enterprises lack quality awareness and advanced quality management.

They also pay little attention to improving quality management by using SPC, TQM, Six Sigma, etc. while they carry out ISO 9001 quality management system certification. Some companies ask consultancy firms to write all quality system documents and fill out the relevant records, rather than do this by themselves. If the enterprise pays a fee, it can obtain the certificates very easily and then advertise the certification without constraint. Thus, the effect of the quality management system certificate is impaired severely, and the reputation of the ISO 9000 certification is violated.

5.2.2 Problems in the consulting and certification markets

There is a great demand for ISO 9001 quality management system certification in China. Some unqualified domestic consultancies provide system certification assistance illegally. At the same time, foreign consultancies have flooded the Chinese market. So, competition in the Chinese consulting market for quality management system certification is very fierce. Some consultancies simplify the consultancy procedures in order to reduce costs.

Some certification bodies reduce the number of auditors, auditing items, and auditing time on-site. As a result, external auditing does not meet the requirements of the ISO 19011 standard, and enterprises are able to obtain the certificate very easily by paying a fee to consultancies or certification bodies. Although the problems mentioned above exist in only a few consultancy and certification bodies, all consultancy and certification bodies must improve their ability to abide by trade ethics and standards in order to solve these troubles.

5.3 Problems of the ISO 9000 family of standards

The ISO 9000 family of standards plays a key role in international trade because it can be applied in a wide range of situations. But this strength also creates weaknesses. In some cases, these standards are too general and do not provide adequate technical guidelines. A discussion of these weaknesses follows in 5.3.1 and 5.3.2.

5.3.1 Industrial differences are ignored in ISO 9001:2000

ISO 9001:2000 is characterized by its universal applicability to all types of organizations and industries including: manufacturing, government, agriculture, fisheries, computer manufacturing, textiles, food processing, transportation, and education, etc. But in fact, there are great differences in these categories. Quality management of various organizations and trades is unified by the unique standard of ISO. It is incredible that the ISO 9001 standard can be applied in organizations of any type and any size in the world.

5.3.2 Technical requirements are inadequate in ISO 9001:2000

To assure product quality, it is not enough to build up only the software environment. Product quality is closely related to design, raw materials, processing equipment, and testing instruments. All of these factors must be strictly controlled to ensure product quality. Hardware construction must

be integrated into the quality management system, which means technical management must be included in the quality management system. Without technical management, the ISO 9001 quality management system certification does not make commitments to assure products with high quality.

For example, demands on both quality and technical requirements are described in the QS 9000/TS 16949 standard, and therefore the standard has been widely adopted by the auto industry. In another example, the TL 9000 standard in telecommunications also contains quality management and telecommunication technical management requirements. TL 9000 certification is more effective than that of ISO 9000 not only in quality assurance but also in the expansion of market share for telecommunication enterprises.

6 Concluding remarks

The aim of this lecture was to provide some basic and important knowledge of quality management and related topics, such as statistical process control (SPC), Total Quality Management (TQM), the ISO 9000 family of standards, and quality management system certification. By studying these basic quality management methods, readers will gain a foundation for further study. Basic knowledge of quality management and quality management system certification will give readers insight into Total Quality Management and quality assurance systems. Readers will receive help in understanding the above related concepts, by learning the role and critical management techniques of important methods such as SPC, TQM, quality certification (i.e. ISO 9000, QS 9000, TL 9000, HACCP, CSI (Customer Satisfaction Investigation) and Six Sigma. Readers who wish to deepen their knowledge of quality management and standard topics may visit the next section ('Bibliography and Resources') as a starting point.

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8 Glossary

APLAC
Asia-Pacific lab accreditation cooperations, which work in harmony with ILAC and are represented on ILAC's board of management. ILAC is encouraging the development of such regional cooperations in other parts of the globe.

BIPM
The Bureau International des Poids et Mesures (BIPM) was set up by the Metre Convention and has its headquarters near Paris, France. It is financed jointly by the Member States of the Convention and operates under the exclusive supervision of the CIPM. Its mandate is to provide the basis for a single, coherent system of measurements throughout the world, traceable to the International System of Units (SI).

CGPM
The General Conference on Weights and Measures (Conférence Générale des Poids et Mesures, CGPM) is made up of representatives of the governments of the Member States and observers from the Associate States of the CGPM. Each General Conference receives the report of the International Committee for Weights and Measures (CIPM) on work accomplished; it discusses and examines the arrangements required to ensure the propagation and improvement of the

International System of Units (SI); it endorses the results of new fundamental metrological determinations and various scientific resolutions of international scope; and it decides all major issues concerning the organization and development of the BIPM, including the budget of the BIPM for the next four-year period.

CIPM
The CIPM is made up of eighteen individuals, each from a different Member State under the Metre Convention. Its principal task is to promote worldwide uniformity in units of measurement and it does this by direct action or by submitting draft resolutions to the General Conference (CGPM). The CIPM meets annually at the BIPM and, among other matters, discusses reports presented to it by its Consultative Committees. Reports of the meetings of the CGPM, the CIPM and all the Consultative Committees, are published by the BIPM.

Dr Taguchi
Dr Taguchi is well known for his development of Robust Design techniques. His contributions in the field of quality engineering have been used throughout the world. Dr Taguchi is Executive Director of the American Supplier Institute in Livonia, Michigan, USA

EA
European accreditation cooperations, which work in harmony with ILAC and are represented on ILAC's board of management. ILAC is encouraging the development of such regional cooperations in other parts of the globe.

Error of measurement
Error of measurement is the result of a measurement minus a true value of the item being measured.

ILAC
The International Laboratory Accreditation Cooperation (ILAC) is an international cooperation between the various laboratory accreditation schemes operated throughout the world. Founded more than 20 years ago, ILAC first started as a conference in 1978 with the aim of developing international cooperation for facilitating trade by promotion of the acceptance of accredited testing and calibration results.

International standard
The standard recognized by an international agreement to serve internationally as the basis for assigning values to other standards of quantity concerned.

ISO/IEC 17025
ISO/IEC 17025 is the International Standard that specifies the general requirements for the competence of laboratories to carry out tests and/or calibrations.

This standard contains management requirements and technical requirements. It is applicable to all organizations performing tests and/or calibrations.

Laboratory
A laboratory is an institution that carries out the work of calibrating and testing in experimental certification procedures. The aim of the existence of laboratory is to provide society with accurate and credible testing data and results.

Laboratory Accreditation
Laboratory accreditation provides a means of determining the competence of laboratories to perform specific types of testing, measurement and calibration.

Metre Convention
The Metre Convention (Convention du Mètre) is a diplomatic treaty which gives authority to the General Conference on Weights and Measures (Conférence Générale des Poids et Mesures, CGPM), the International Committee for Weights and Measures (Comité International des Poids et Mesures, CIPM) and the International Bureau of Weights and Measures (Bureau International des Poids et Mesures, BIPM) to act in matters of world metrology, particularly concerning the demand for measurement standards of ever-increasing accuracy, range and diversity and the need to demonstrate equivalence between national measurement standards.

Metrology
Metrology is the science of measurement, embracing both experimental and theoretical determinations at any level of uncertainty in any field of science and technology.

MRA
Mutual Recognition Arrangement (MRA) is an arrangement between two or more parties to mutually recognize or accept some or all aspects of one another's conformity assessment results (e.g. test reports, certificates of compliance). Through MRAs, products that are tested and/or certified before export can enter the importing country directly without having to undergo similar conformity assessment procedures in the importing country.

National standard
The standard recognized by a national decision to serve as the country's basis for assigning values to other standards of the quantity concerned.

NIST
Founded in 1901, NIST (National Institute of Standard and Technology) is a non-regulatory federal agency within the US Commerce Department's Technology Administration. NIST's mission is to develop and promote measurement, standards and technology to enhance productivity, facilitate trade and improve the quality of life.

OIML
The International Organization of Legal Metrology (OIML) is an intergovernmental treaty organization whose membership includes Member States, countries which participate actively in technical activities and Corresponding Members, countries which join the OIML as observers. It was established in 1955 in order to promote the global harmonisztion of legal metrology procedures.

Primary standard
A primary standard is a standard that is designated or widely acknowledged as having the highest metrological qualities and whose value is accepted without reference to other standards of the same quantity.

PTB
Physikalisch-Technische Bundesanstalt (PTB) is the national metrology institution of Germany, which provides scientific and technical services.
Metrology is the PTB's core competence and it measures with the highest accuracy and reliability.

Quality loss function
Quality loss function is a function that describes the quality loss caused by the deviation of quality characteristic and design object.

Reference standard
A reference standard is a standard generally having the highest metrological quality available at a given location or in a given organization from which the measurements made at that location are derived.

Secondary standard
A secondary standard is a standard whose value is assigned by comparison to a primary standard of the same quantity.

Traceability
Property of the result of a measurement or the value of a standard whereby it can be related to a stated reference, usually national or international standards, through an unbroken chain of comparisons, all with stated uncertainties.

Uncertainty of measurement
Uncertainty of measurement is a parameter associated with the result of a measurement (e.g. a calibration or testing) that defines the range of the values that could reasonably be attributed to the measured quantity.

Verification
Conformation through examinations of a given item and provision of objective evidence that it fulfils specified requirements.

9 Key questions

- What are the main contents of ISO 9001:2000 ?
- What are the benefits of ISO 9000 standards?
- What are the procedures of quality management system (QMS) certification?
- What are the functions of the Quality System Audit?
- What is the essence of quality management?
- What is the purpose of the cause-effect diagram?
- What is the principle of the Pareto chart?
- What is the meaning of Total Quality Management (TQM)?
- What are the principles of TQM?
- What are the procedures of TQM?

Niranjan Gunawardena

Abstract

The increasing global consciousness in environmental protection, government policies and regulations, and pressures from consumers and interest groups have nurtured the evolution of environmental management systems (EMSs). An EMS provides companies with a systematic approach to address environmental protection and utilise their resources for achieving strategic environmental goals. Section 2.1 of this lecture presents some widely used EMSs. The major components of the most recognised EMS framework in the world, ISO 14001 standard, are discussed in Section 2.2. There are several issues related to the implementation of ISO 14000 EMS in companies; as presented in Section 2.3, these include: reasons and critical success factors for implementation, costs and benefits of ISO certification, impediments of the standard, and its possible integration with other management standards. First-hand information regarding these issues was obtained from a case study, which is summarised in Section 2.4. The worldwide diffusion of ISO 14000 is discussed in Section 2.5 together with some influencing factors. Finally, concluding remarks are given in Section 3.

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1 Preface

It is now believed that more than a century of industrial development has come at a price: global warming, depletion of the ozone layer, pollution of air and water, soil erosion and deforestation, which are widely recognised as the major environmental issues of today (Banerjee, 2001, p.489). During the last few decades, there has been an increased awareness about the environment among governments, companies, the general public and interest groups all over the world. The competitive advantage of a company is affected by its strategies with respect to quality and environmental impact of its products and services. Companies that provide high-quality and environmental friendly products and services are likely to have a greater potential to achieve a large market share and returns (Pun and Hui, 2001, p.333). This, apparently, is evident among multinational companies (MNC) who have taken environmental management on board as a corporate strategy. According to previous research (Pun et al., 2002, p.691), many successful companies provide excellent examples as to how well-formulated environmental strategies could lead to business advantages such as better quality, reduced costs, improved company image, relations with customers, and the opening of new markets. By implementing an Environmental Management System (EMS), companies could integrate environmental values into their operations. A company implementing an EMS accepts responsibility for the protection of the environment and for ensuring continual improvement of its environmental performance (da Silva and de Medeiros, 2004, p.380-382).

2 Implementation of ISO 14000 Environmental Management Systems

2.1 Environmental Management Systems (EMSs)

An Environmental Management System (EMS) provides a systematic approach to address environmental protection and utilise organisational resources for achieving corporate environmental objectives (Pun et al., 2002, p.690). It enables a company to address environmental effects through policy development and implementation, allocation of responsibilities and resources, and the continual improvement of practices and performance based on monitoring and evaluation (Spellerberg, et al., 2004, p.126). Within an EMS, usually, particular attention is given to issues such as energy efficiency and waste pollution control (Newton and Harte, 1997, p.76).

An EMS is based on voluntary rules or practices that companies can adhere to in order to control the environmental impact of their activities.
There are a number of models available for developing an EMS. Many countries have been using these models for more than two decades. For example, BS 7750 was published in the United Kingdom in 1992; the European Union has had the Eco Management and Audit Scheme (EMAS) since 1993 (UNCTAD, 1997, p.5). At international level, ISO 14001 has been widely used since 1996 (Chavan, 2005, p.445). The strategies adopted by companies in implementing an EMS could be based on environmental performance. Both environmental performance and continuous improvement of an EMS could be monitored and evaluated. Such an evaluation would depend, mainly, on performance indicators used by the company to measure its level of efficiency and effectiveness with respect to environmental management (da Silva and de Medeiros, 2004, p.382).

Structure of an EMS

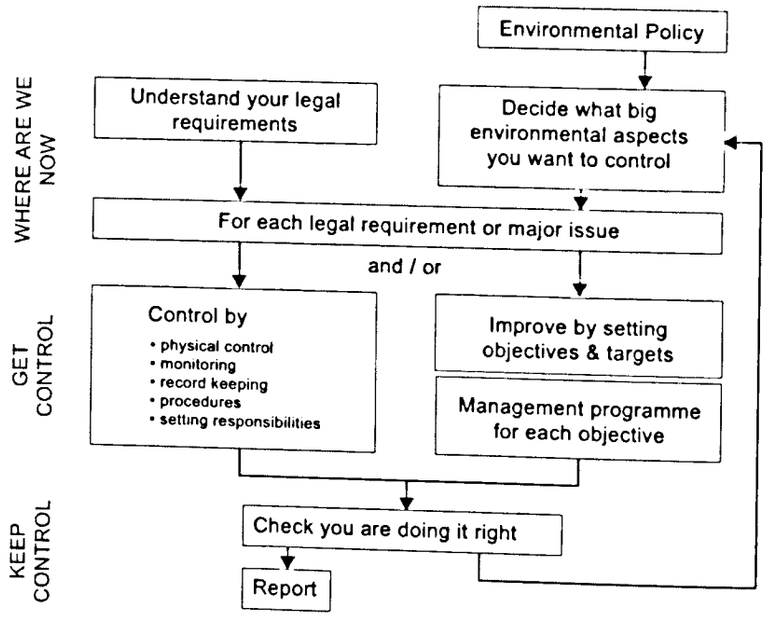


Figure: Structure of an EMS (Source: www.atkinsglobal.com)

2.1.1 History of Environmental Management Systems (EMSs)

Some trace the origin of EMSs to the UN conference on Human Environment held in Stockholm in 1972. The report of this conference called for industry to develop effective environment systems (Line, 2002, p.13), which later led to the UN conference on environment and development (the Earth summit) in Rio de Janeiro in 1992. The Uruguay round of the General Agreement on Tarifs and Trade (GATT) negotiations and the Rio Summit could be considered as the beginning of the ISO 14000 series (Tse, 2001, p.178). GATT focused on the needs of reducing non- tariff barriers to trade (NBT) and the Rio Summit, on the protection of the global environment. In preparation for the Rio summit, ISO established the Strategic Advisory Group on Environment (SAGE) in 1991 to make recommendations with regards to international standards. Following SAGE's endorsement for the development of environmental management system standards, the ISO technical management board established a new technical committee, TC 207, for this purpose. In 1992, the British Standards Institution (BSI) developed the BS 7750 standard, which was followed by the European Eco-Management Audit Scheme (EMAS) in 1993. The ISO 14001 was completed by TC 207 in 1996 (Chudnovsky and Lopez, 1999, p.11). Both BS 7750 and EMAS are broader in their requirement than ISO 14001 (World Bank, 1998, p.130). Of the various EMS approaches, however, the ISO 14000 serious is the most widely known (World Bank, 1998, p.129).

2.1.2 BS 7750 Environmental Management Standard

The British Standards Institution's (BSI) standard on environmental management system, BS 7750, was launched in 1992 as the first EMS standard in the world; in fact, it has emerged from a combination of the theory of environmental management and total quality management (TQM) (Holt, 1998, p 206). The standard describes how a company could ensure compliance with its own environmental policies, objectives and targets, and also how to demonstrate this to the outside world (Bohoris and O'Mahony, 1994, p.3). It does this by providing a framework to support environment reviews and audits, which are considered to be the key elements to improved environmental performance (Grayson, 1992, p.6). The standard does not limit the environmental aspects considered only to existing legislation and regulations; a company may include more stringent environmental objectives, even those of a non-regulatory nature, in its EMS (Mason, 1994, p.4). A company complying with BS 7750 should verify that the intended environmental performance is being achieved and sustained effectively (McClosky and Maddock, 1994, p.27). Records of this verification are maintained to be audited by accredited assessors approximately once every six months (Bohoris and O'Mahony, 1994, p.3). BS 7750 has been designed to have high compatibility with BS 5750 on quality

management systems and the EU Eco Management and Audit Scheme (EMAS) (Mason, 1994, p.4).
This British standard was formally withdrawn in February 1996 with the introduction of the ISO 14001 standard during the same year (Holt, 1998, p.206).

2.1.3 Eco Management and Audit Scheme (EMAS)

Eco Management and Audit Scheme (EMAS), which is an emanation of EU council Regulation No. 1836/93/EC, is a voluntary environmental management scheme for European companies (Charlier, 1998, p.106). The purpose of EMAS is to encourage companies to assess and improve their environmental performance continually. The companies in the EU member countries may choose whether or not to participate in the scheme; a company participating may also decide whether to register all or some of its facilities (sites). Although the regulation is not binding on companies or individuals, the member states are required to establish systems for accreditation of environmental verifiers, and competent bodies responsible for registration of participating organisations. In contrast, the adoption of ISO 14001 is purely voluntary for any country or an organisation (Watson and Emery, 2004a, p.761-672).

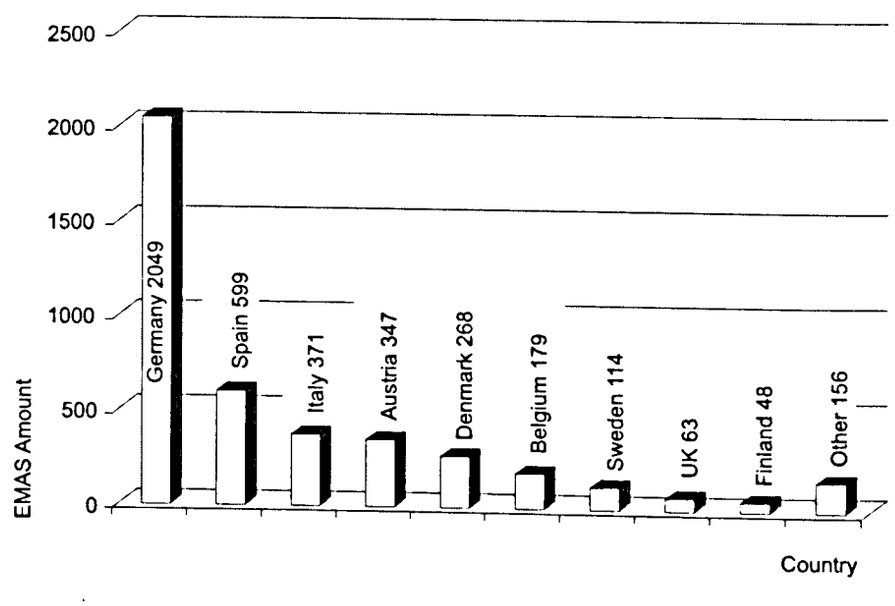


Figure: EMAS Registrations in Europe (Source: www.ecology.org)

Compared to ISO 14001, EMAS places more focus on external stakeholders. Companies participating in the scheme are required to publish an environmental statement to inform the public about their environmental-related actions and their progress (Freimann and Walther, 2001, p.92). Therefore, a participating company is required to perform environmental audits at the registered sites at least every three years through an auditor not directly involved with the system, and a written report is made available to the public. Based on the results, an environmental statement is prepared for each site and verified by an accredited environmental verifier who is independent of the auditor. Companies satisfying the requirements of EMAS are entitled to use a logo on their letter heads, brochures, and financial statements as well as in advertisements. EMAS also has provisions to recognise companies accredited under similar national schemes within the EU. Promoters of EMAS stress that the advantages of the scheme are not limited only to the implementation of good environmental practices, but also include the enhancement of a company's overall credibility relative to its environmental efforts in the eyes of regulators, policy makers and the general public. In general, EMAS is more demanding than ISO 14001 (Freimann and Walther, 2001, p.96); it has requirements for continuous or continual improvement of performance and for communication with the public that are not present in 14001 (World Bank, 1998, p.130).

2.1.4 ISO 14000 series of standards

Inaugurated by the ISO in 1996, the ISO 14000 series of standards presents a common framework of tools for managing environmental issues. ISO 14001 is considered as the world's most recognised EMS framework accepted from Argentina to Zimbabwe (Anon, 2002, p.4); the standard was originally published in 1996 and revised in 2004. There are over 103,000 facilities certified to ISO 14001 in about 136 countries across the globe (CRM, 2006, p.1) The series includes standards for: environmental management systems, terms and definitions, environmental auditing, environmental performance evaluation, environmental labelling, and life cycle assessment The latter involves the identification and evaluation of the environmental aspects of products from the 'cradle to the grave' or from the extraction of resource inputs to the eventual disposal of the product or its waste (Anon, 2002, p.5). Recently, the series has been expanded to include standards on environmental communication and climate change. ISO 14000 is different from most other ISO standards: it is a generic management system standard like ISO 9000. The meaning of 'generic' is that it can be applied to any organisation, large or small, whatever its product or service, in any sector of the economy and whether it is state-owned or private. Whereas, management system means that the way the organisation manages its processes, not products (Lighthouse Consulting, 2003, p.1). According to the Chairman of the US Technical Advisory Group (TAG) to TC 207, ISO 14000 is not a detail-specific biosphere standard (Anon, 1995, p.29).

The ISO 14000 series of environmental management standards is an offshoot of the ISO 9000 programme, which set global standards for quality management systems (Begley, 1996, p.50). However, many believe that the impact of ISO 14000 will far exceed that of ISO 9000 (Jackson, 1999, p.16 OO).

ISO 14000 series of standards

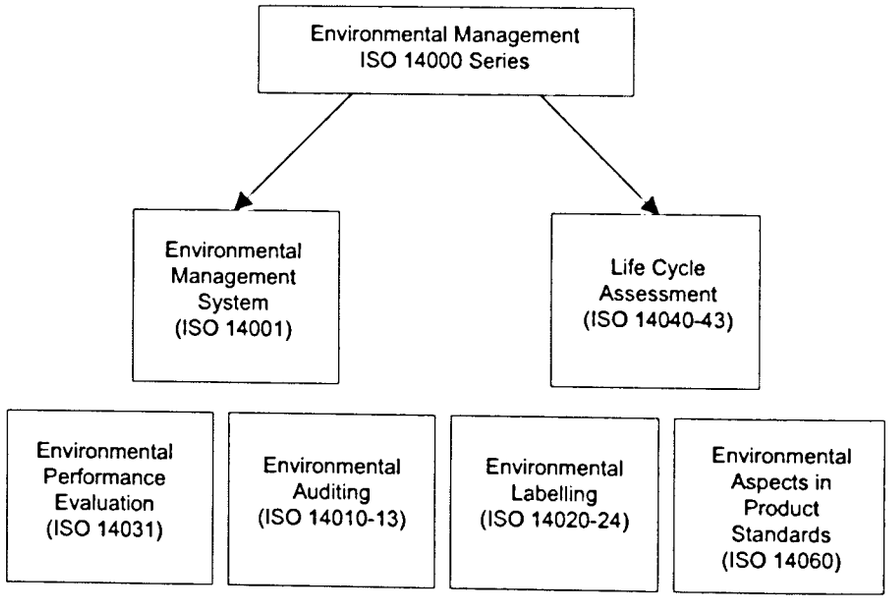


Figure: ISO 14000 series of standards (Source: Anon, 1995, p.29, Harmazi, 1997, p.34)

The ISO 14000 family provides management tools for companies to control their environmental aspects and to improve their environmental performance. The tangible economic benefits received through these standards include (ISO, 2002, p.5):

- Reduced raw material/resource use,
- Reduced energy consumption,
- Improved process efficiency,
- Reduced waste generation and disposal costs and
- Utilisation of recoverable resources.

The term ISO 14000 is used to identify the entire series of environmental management standards; of these ISO 14001 is the main standard that provides the EMS model. The ISO 14001 EMS model is based on the Deming's Plan-Do-Check-Act cycle (Graff, 1997, p.19).
It has five major components (ISO 14001, 2004, p.2-5):

1. Environmental policy
2. Planning
3. Implementation and operation
4. Checking and corrective action, and
5. Management review

Deming's Plan-Do-Check-Act Cycle

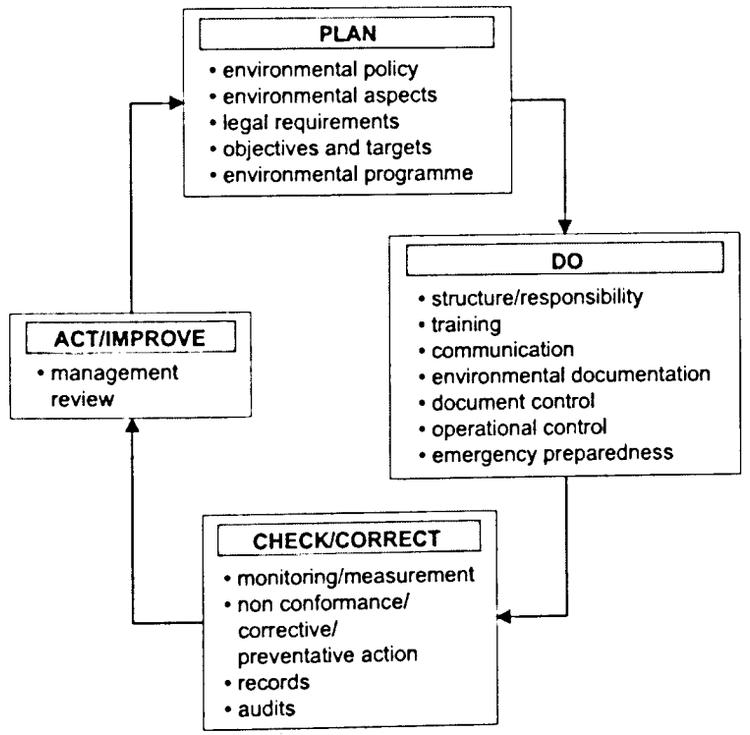


Figure: Deming's Plan-Do-Check- Act Cycle (Source: www.uneptie.org)

2.2 Components of the ISO 14001 standard

The ISO 14001 EMS has the following five components (ISO 14001, 2004, p.2-5; Graff, 1997 p.19; Boiral and Sala, 1998, p.58; Daily and Huang, 2001, p.1541-1543):

2.2.1 Environmental policy

This can be considered as the road map for improving a company's environmental performance. The policy includes a commitment by top management to continual improvement of the EMS, prevention of pollution and compliance with legal as well as other requirements to which the organisation subscribes (e.g. codes of practice). The policy must be communicated to all employees and also, be available to general public.

2.2.2 Planning

This involves identification of legal requirements and understanding how a company's activities affect the environment. The company could develop a plan to reduce adverse effects that these activities may have on the environment. With respect to the above, environmental impacts, objectives and targets could be established and then an action plan could also be developed for accomplishing them. It is desirable to involve all employees during the planning stage.

2.2.3 Implementation and operation

The policy and the action plans established could be documented and communicated to employees for proper implementation. It may be necessary to assign responsibilities to employees and train them to ensure that they are aware of the action plan and competent to perform any required duties related to it. As a part of the documented system, operation procedures (and work instructions) may be required to properly carry out specific activities.

2.2.4 Checking and corrective action

The checking and corrective action could include monitoring and measurement, rectification of non-conformances, and corrective and preventive action, records, and EMS audits, both internal and third-party. The company is required to establish and maintain programmes to carryout internal audits to determine whether the EMS conforms to requirements of the standard.

Results of internal audits and other activities such as corrective action are provided to the management for periodic review.

2.2.5 Management review

The top management could review the EMS on a regular basis, for example semi-annually or annually. The purpose of this review is to determine the effectiveness and the adequacy of the EMS. The outcomes of the management review may lead to changes in the environment policy, objectives, targets and other elements of the EMS, which in turn is expected to result in continual improvement. Unlike EMAS, ISO 14000 defines 'continual improvement' as improvement of the EMS, rather than of environmental performance itself, although improvement of the EMS is expected to lead ultimately to improved environmental performance.

2.3 Issues Related to Implementation of ISO 14001 EMS

2.3.1 Development and Certification of an EMS

Developing an EMS to ISO 14001 includes collection of a company's policies and procedures for environmental-related functions, defining its organisational structure, identifying the laws and regulations under which it operates. The ISO 14001 standard strongly recommends (in its information annex) that companies which do not have existing an EMS should carry out an initial review of their current management system to determine if their procedures and practices can be incorporated into the formal requirements of the ISO 14001 standard. The ideal method, according to experts, is to do a 'gap analysis' to identify missing or weak elements (Hormozi, 1997, p.35). This enables the company to identify those additional procedures or that information which could be collected, developed and organised to establish an auditable EMS (Sharpe, no date, p.4) and to determine exactly what further actions would be required to achieve the certification (World Bank, 1998, p.132). ISO 14001 is essentially a documented management system; as a part of this, the environment manual, operation procedures, work instructions and forms for maintaining records could be developed. The approach adopted by a company in developing the EMS must, also, consider the need to link it with other management systems such as quality and health and safety (Lawrence et al., 2002, p.49). Seeking the assistance of an external consultant to complete the documentation and implementation of the ISO 14001 standard is an option at this stage. However, developing internal expertise is also crucial for long term survival of the EMS (Zutshi and Sohal, 2005b, p.469).

There are several ways for an organisation to demonstrate its conformity with ISO 14001, ranging from self-declaration to formal third-party certification, with various forms of second- and third-party confirmation in between. Conscientious implementation provides the same internal benefits as does a certified system. Third-party certification is widely viewed as more credible, but it can be very expensive, especially for small and medium-sized enterprises (SME), and may not be worth the cost for many companies. The ISO does not itself certify companies for ISO 14000 or other standards. Certification is done by independent third-party organisations. Third-party certification refers to the assessments carried out by a certification body to assure a company complies with the appropriate standards (Hormozi, 1997, p.37). Development of an EMS such as ISO 14001 in small- and medium-sized enterprises (SME) is considered to be difficult compared to large companies (World bank, 1998, p.134). The reasons include the lack of formal management structures, technically trained personnel and short-term cash flow problems.

2.3.2 Reasons for implementation and certification

The reasons for companies seeking ISO 14001 certification include (Hormozi, 1997, p.37; Poksinska et al., 2003, p.593; Lawrence et al., 2002, p.43; Hall et al., 1999, p.2; Corbett and Luca, 2002, p.8; Heisz et al., 2002, p.24):

- Competitive advantage
- Enhancing corporate (company) image
- Marketing advantage
- Incentives offered by government to certified companies
- Better relation with authorities
- Cost savings and improved management control
- Meeting customer requirements and expectations
- Demonstrating commitment to environmental responsibility
- Improved environmental performance
- Staying ahead of legislation
- Increased employee motivation
- Improved community relations

The marketplace appears to be the main driver behind a company's environmental strategy to implement ISO 14001. A survey indicates, for example, that 50% of companies have implemented the EMS due to customer demand or the competitive advantage of certification (Graff, 1997, p.19). Another study carried out in Far Eastern countries, including Japan, shows that corporate image, environmental improvement, market advantage, and improved relations with communities are the most important reasons for certification (Pan, 2003, p.571).

However, in Germany, France, Netherlands, and United Kingdom, meeting the (National) regulations has been the main reason for implementing an EMS (Alberti et al., 2000, p.4464). Another motivation for achieving ISO 14000 certification is the perception that it allows companies to enter the global market-place in much the same way that ISO 9000 certification has done. Particularly, in the European market, the customer demand for environmentally conscious business is evident (Driso Ltd., 2005, p.3). 'Green' production has in fact, (after quality and cost) become the third most important reason for purchasing a product) in the European Union (Driso Ltd., 2005, p.3). The results of a study done in the United States, show that motivations for implementing the ISO 14001 EMS include the perceived improvement of environmental performance. For companies whose motivations included increased marketing potential, competitive advantage and revenues appear to have reported significantly higher levels of environmental performance improvement (ISDR, 2003, p.5).
The above motivations clearly imply that the companies planning to implement or implementing an EMS to ISO 14001 expect more than just a certificate to display on the wall (Lawrence et al., 2002, p.43). More research is needed, however, to determine whether, to what extent and in what circumstances implementation and/or certification of an ISO 14000 EMS leads to improved business performance, environmental performance or legal compliance (Wood, 2006, p. 229-276).

2.3.3 Costs of implementation and certification

Developing and implementing an EMS to ISO 14000 can cost both time and money. The time required for implementation of the system can be between four months to two years (Tse, 2001, p.185). Companies make substantial cost commitments in implementing an ISO 14001 EMS as well; of these, labour costs are considered to be significant. How much does it cost to implement an EMS to ISO 14001? An earlier study estimates the implementation costs to be between $ 15,000 and $ 150,000 per facility (Graff, 1997, p.19). However, the certification and surveillance audit (KEY NEW) costs could also be added to this. According to a more recent study by Schylander (2004, p.54), over 90% of the costs associated with ISO 14001 is spent on implementation of the EMS. Compared to EMAS, ISO 14001 implementation is more expensive and according to a study reported by Freimann and Walther (2001, p.97), the average cost of implementation is about € 195,000. The external validation and certification costs appear to be lower for ISO 14001 compared to those for EMAS; according to Freimann and Walther (2001, p.97), the average certification cost is about € 18,000.

However, the costs of EMS implementation may vary from one country to another; for example, the costs in Germany are considered to be half those spent for EMS implementation in Switzerland (Freimann and Walther, 2001, p.97).

2.3.4 Benefits of implementation and certification

Internal benefits perceived by companies include (Hall et al., 1999, p.4; Quazi, 1999, p.306; Corbett and Luca, 2002, p.8; Poksinska et al., 2003, p.589):

- Reduced environmental incidents and liability
- Increased efficiency
- Improved environmental performance
- Improved corporate culture
- Greater environmental awareness
- Cost savings
- Reduced wastage
- Improved documentation and internal procedures
- Fewer conflicts between departments

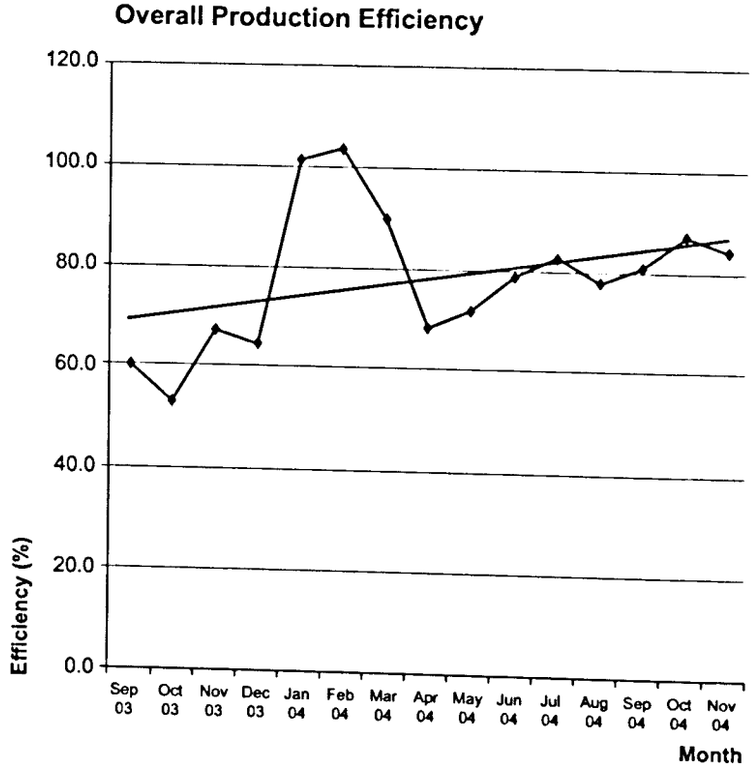


Figure: Increased Efficiency - Brandix Finishing Ltd. (© Bandix Finishing Ltd.)

The direct or internal benefits of an EMS are believed to come from savings through cleaner production and waste minimisation approaches. Even simple and cheap process improvement may lead to the prevention of about 50% of the pollution generated in a typical 'uncontrolled' plant (World Bank, 1998, p.131). According to a research on EMS carried out in the United Kingdom, there are improvements in measurable attributes associated with waste, water, and energy management that lead to direct cost savings (Holt, 1998, p.212).
The best results are very likely for sites or facilities of large companies (e.g. publicly traded companies) owing to the availability of greater resources, but EMS can be successful in small (privately held) companies and government organisations as well. The average (annual) benefits for all organisations are reported to be around US$ 90,000 mainly through the reduction of materials used, which accounts for over 50% of the total savings (ISDR, 2003, p.4-5). Another study carried out among companies shows that the annual savings from the implementation have been more than US$ 250,000 (MSI, 2005, p.2).
The external benefits may include (Hall et al., 1999, p.4; Corbett and Luca, 2002, p.8; Poksinska et al., p.589):

- Improved competitive edge
- Enhanced company image
- Increased market share
- Improved regulatory compliance
- Improved relations with authorities
- Improved relation with communities

A resent study (Chavan, 2005, p.449) identifies the main (external) benefits of an EMS based on ISO 14001 as clean and effective operations, market expansion and improvement of company image. Such a commitment to 'Greener Practices' is synonymous with a commitment to 'sustainability' (Fisher, 2003, p.139), which enables companies and countries to achieve 'sustainable development'. Another study shows that the implementation of ISO 14001 could reduce a company's (facility's) time spent out of compliance with regulations by about 7% (Potoski and Prakash, 2005, p.246) and that the time out of compliance is less than that for a non-certified company.

2.3.5 Critical success factors for implementation of an EMS

Many studies (Quazi, 1999, p.303; Daily and Huang, 2001, p.1539; Poksinska et al., 2003, p.590; Berthelot and Coulmont, 2004, p.39; Wee and Quazi, 2005, p.104) have established Critical Success Factors (CSF), which are significant or essential for the implementation and maintenance of an EMS; the presence of these, however, does not guarantee improved environmental performance of a company. The following are some common CSFs:

Top management commitment
Top management commitment is considered to be the most important factor for ISO 14001 implementation. The top management must provide leadership to employees at all levels (Zutshi and Sohal, 2004, p.401). This means that the top management should communicate the importance of EMS to employees and motivate them to get involved in the environmental activities (Poksinska et al., 2003, p.590). Other aspects where the top management could offer their support include setting environmental policy, objectives, and targets, training of employees, and provision of adequate and timely resources for the implementation of the EMS.

Total involvement of employees and inter-disciplinary implementing team
Employee participation is yet another important implementation factor. Employees can play a major role in the development and implementation of the ISO 14000 environmental management system. It is a known fact that they are more likely to follow procedures that they have developed themselves. It is also believed that there is an association between 'employee dissatisfaction' and 'nonconformity' with the standards; unhappy employees are more likely to make careless mistakes (Wilson and Sasseville, 1999, p.25). Also, the team implementing the EMS must have a good mix of technical, socio-economic, environmental, and auditing expertise. The team must consist of (senior as well as lower level) employees from each department of the company. The management must encourage teamwork and initiatives taken by employees at all levels to ensure a widespread 'buy in' effect (Balzarova et al., 2006, p.100); it is also important to engage employees from the earliest stages to ensure that the EMS is integrated into the corporate culture (Pawar and Rissetto, 2001, p.12). Further, rewards and incentives are effective in motivating employees to be environmentally responsible (Govindarajulu and Daily, 2004, p.368).

Defining responsibilities and delegating authority
As with ISO 9001, for successful implementation of an ISO 14001, the roles, responsibilities and authority of key personnel in the EMS should be well defined. This allows them to have better understanding their activities and to avoid possible conflict in carrying out their duties with respect to the EMS.

Focus on business needs in identifying environmental aspects
The aim of the company should not only be to obtain the certification. Therefore, the objectives of the EMS should be in line with the corporate objectives; if not, this could lead to lack of top management support in the long run. Furthermore, the environmental strategies and the management system should be compatible with the corporate culture and the core competencies of the company; this may be useful to overcome any resistance to implementation of the EMS.

Training
All employees whose activities have an impact on the performance of the EMS should be trained to carry out their duties and to achieve environmental objectives and targets (Chin et al., 1999, p.344). Educational programmes could be offered to employees for increasing their environmental awareness. All such training programmes should be reviewed for improving their effectiveness with respect to both scope and content.

2.3.6 Impediments of ISO 14001 EMS

There are several impediments with respect to ISO 14001 EMS, despite the many benefits highlighted earlier. These are related to two main aspects: high cost commitment and compliance-based certification.

High cost commitment
Implementation and certification of an EMS to ISO 14001 needs high cost commitment in terms of both time and effort. Although surveys show that an increasing number of customers want to buy environmentally friendly products and in some instances would be willing to pay more for them (Environment and Labour, 2004, p.2), this may not always be the case. There are a host of factors customers consider before making the buying decision, even if price could be a prime factor to them (D'Souza, 2004, p.1). Companies who do not receive cost savings as a result of the ISO 14001 EMS would have to add its implementation, certification and maintenance costs to the price of the products or reduce their profit margins.

The benefits of ISO 14001 certification are mainly reported by large companies because small and medium-sized enterprises (SME) realise relatively small returns on their certification costs due to low turnover (Chavan, 2005, p.448). Financial constraints could be considered as one of the first possible barriers in implementing an EMS to improve environmental performance (Biondi et al., 2000, p.57). Therefore, only few SMEs can afford the investment in time and money to effect the necessary changes (Holt, 1998, p.205) and still be competitive in the market. Due to this, small companies attempt to perform internal audits and self-declare that their environmental management systems meet the requirement of the ISO 14001 standard (Environment and Labour, 2004, p. 2). Alternatively, many SMEs may pursue some intermediate form of external confirmation of their EMS which provides some of the credibility of a third-party check without the cost of certification (see EnviroReady Reports, http://www.14000registry.com/sme.asp).

Compliance-based certification
It is believed that the actual content of an EMS is a more important than the mere existence of the EMS or even the fact that it has been certified to ISO

14001 (HWC, 2003, p.1.10). The standard leaves it to the company to determine the environmental aspects it needs to control depending on regulatory demands (Anon, 1995, p.29). This problem with certification had been identified by the industry even before ISO 14001 was introduced in 1996. As pointed out by Simmons and Wynne (1994, p.16), the certification confirms that an EMS is in operation and is being complied with. The content of such an EMS is determined by a policy statement that describes a company's environmental objectives. In theory, these objectives can aim no higher than regulatory compliance or the legal minimum; yet, the company can obtain certification (Newton and Harte, 1997, p.91). For this reason, ISO 14001 is considered to have the minimum requirements compared to other EMS models such as the Eco Management Audit Scheme (EMAS) and Responsible Care (Zutshi and Sohal, 2002, p.15).

Like other management standards, ISO 14001 is a compliance standard, not a performance specification. Compliance with ISO 14001, therefore, does not guarantee that the company has achieved improved environmental performance. A common criticism of this practice is that companies can set environmental objectives and targets that are relatively easy to achieve (Poksinska et al., 2003, p.589). Sometimes, this allows businesses that are high polluters to have leaner environmental objectives (D'Souza, 2004, p.6). For this reason, some are more sceptical about the real value of an ISO 14001 EMS.

2.3.7 Integrated Management Systems (IMS)

Companies have realised that establishing and maintaining separate management systems to deal with quality, environment, safety etc. and also ensuring that they align with the corporate strategy would be difficult to achieve (Wilkinson and Dale, 1999a, p.95). Therefore, integration of management systems became a subject of increasing interest among both researchers and business during the latter part of the 1990's (Wilkinson and Dale, 1999b, p.279). Some factors supporting such integration are as follows:

- As many EMSs have been developed based on the basis of total quality management (TQM) guidelines, it may be possible to easily incorporate environmental aspects into an existing quality management system (Pun et al., 2002, p.691). Hormozi (1997, p.36) agrees that if an ISO 9000 QMS is in place, this is a good foundation for ISO 14000.
- Further, the main criticism of management systems such as ISO 9000 and ISO 14000 is the burdensome documentation requirements. Companies having an ISO 9001 QMS already in place are at an advantage in implementing ISO 14001 because there is no need to duplicate common administrative elements such as document control and record keeping systems (Graff, 1997, p.19). Integration of ISO 14001 and ISO 9001 has direct benefits in terms of cost reduction; it is estimated that independent certification to ISO 14001 could be up to 30% higher than that of ISO 9001 (Cichowicz, 1996, p.78).

- Separate third-party audits would not be needed for ISO 9000 and ISO 14000 because of similarities in structure and documentation between them (Affisco et al., 1997, p.19). Implementation of an EMS can also be a catalyst for simple changes that make up 'good housekeeping' in a company (World Bank, 1998, p.131). This enables the EMS to be integrated with house-keeping practices such as the 5-S system.

Correlation between EMS and QMS

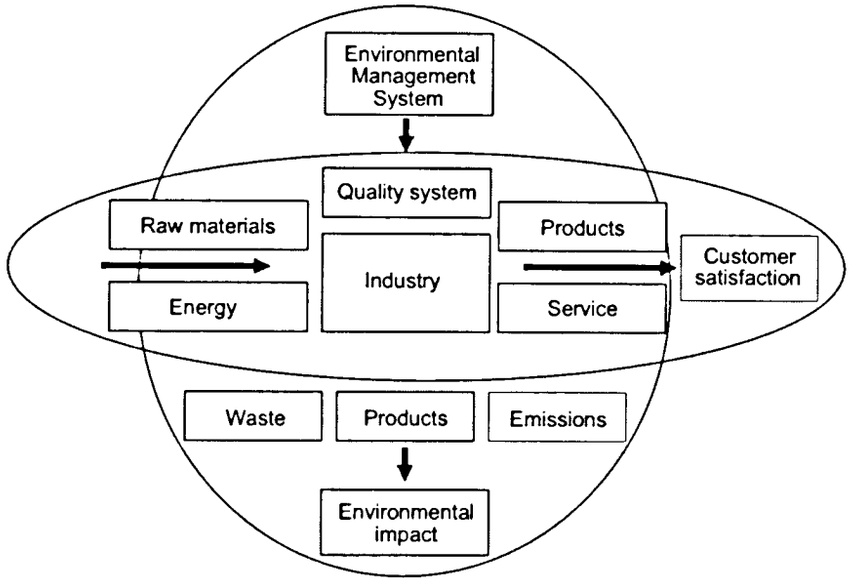


Figure: Correlation between EMS and QMS (Source: Borri and Boccaletti, 1995, p.39)

Although there are many similarities between the two standards encouraging companies to integrate them, there are fundamental differences as well: while ISO 9001 is used to address needs to the customers, ISO 14001 is more concerned about the regulators and the public (Zutshi and Sohal, 2005a, p.214). In ISO 9000, the level of performance or quality is defined by the customer; in the case of ISO 14000, the performance criteria applicable to environmental aspects of the organisational activities must be used. These criteria may include international and national laws and regulations in addition to any voluntary industry requirements of the organisation (Shape, no date, p.4).
Further, the environmental performance of a company cannot be easily measured through feedback from its customers or product sales as in the case of quality (Rothenberg et al., 2005, p.6).

2.4 Case study on ISO 14001 implementation

2.4.1 Company profile

Established in 1996, Brandix Finishing Ltd. (BFL) is considered to be the largest industrial washing and dyeing facility in Sri Lanka providing wet processing facilities including enzyme, stone, bleach and rubber ball washes as well as a diverse range of finishes such as tinting, tie-and-dye and dip-dyes. The company is situated in Ratmalana, an industrial area about 15 km south of Colombo and provides employment for more than 1000 workers. It has about 12,600 square metres of floor area equipped with state-of-the-art facilities to carry out dyeing, special finishes, sandblasting, whiskering, and permanent creasing. Brandix Finishing is also one of the few finishing facilities in the world to work with its buyers and designers in developing new design concepts. It has an advanced Research and Development facility to develop various types of washes and to introduce environmental-friendly chemicals. At present the factory runs at a capacity of 240,000 garments per week for clients in the United States of America and the United Kingdom.

Like other companies in the industrial garment washing and finishing sector, the business of the company is based on water. The company has identified wastewater generation as a significant environmental issue and installed a fully-fledged wastewater treatment plant with physical, biological and chemical treatments to reduce the environmental impacts. From its inception, the company has made every effort to reduce the environmental impacts and to operate in an efficient and organised manner. Good environmental performance is now a business issue and the company has implemented an EMS to ensure that this is addressed in a systematic manner.

2.4.2 Reasons for implementation of the EMS

The main reasons for BFL to implement ISO 14001 EMS were:
- Pressure from customers
- Facilitating compliance with regulatory requirements
- Enhancing company image
- Improving profitability

The regulatory requirements were mainly related to the National Environmental Act (NEA) and the requirements necessary to obtain the Environmental Protection License (EPL). Other requirements related to interested parties included: industry codes of practice, non-regulatory guidelines, and requirements stipulated by customers. The company's Corporate Social Responsibility (CSR) was the main driver to enhance its company image as a community leader in environmental protection. Like many in the textile sector, BFL believes that in

order to be competitive in the market and meet customer requirements, it is essential to reduce its operating costs and look beyond regulatory compliance. Companies in the textile industry use large quantities of natural resources such as water: many processes use chemicals and solvents. They produce solid waste and discharge effluent and emit dust and fumes into the atmosphere, making a noticeable impact on the environment (GPG, 1998, p.2). The average water consumption in the garment sector, according to a study carried out in the UK, is about 161 cubic metres/tonne (EPG, 1997, p.7). During the dyeing process, not all the dye is fixed. The amount of unfixed dye depends on the fibre type as well as the dye type (GPG, 1997, p.5). Further, it is known in the industry that environmental measures could lead to a reduction in water and effluent costs in textile companies by 20% or more; energy bills could be cut down by about 10% through good housekeeping and tighter control (GPG, 1998, p.6). Thinking along these lines, the top management of BFL considered that achieving profitability was also a good reason for seeking ISO 14001 certification.

2.4.3 Development of the EMS

According to the 'Environmental Vision' of BFL, the company is committed to sustainable development, balancing economic progress with environmental care and social responsibility. To achieve its vision, the top management of BFL has established an environmental policy, which addresses issues such as prevention of pollution, regulatory compliance and continual improvement. This policy has been implemented through an EMS developed on the basis of ISO 14001. The company also created a steering committee, led by the Chief Executive Officer, at early stages of implementation, the main responsibility of which was to meet regularly to:
- Discuss progress of implementation
- Review objectives and targets (also to set new ones)
- Discuss other elements of the EMS

The BFL factory has a well-established, Environmental Management Division. This division is made up of the Environmental Management Representative (EMR) and an EMS Coordinator. The EMR's main duties include:
- Undertaking the initial review (identification of environmental aspects)
- Implementing and maintain the EMS
- Coordinating the input from other personnel with environmental responsibility

The identified environmental aspects were then evaluated to determine the significant environmental aspects using a criterion based on factors such as: severity, magnitude (volume), occurrence, availability of controls, applicable legal requirements and concerns of interested parties. In order to bring about environmental improvements the company had to set specific environmental

objectives and realistic targets; when targets were set, the individuals responsible for meeting them were also identified. This was important as it was necessary to demonstrate the company's effort in achieving the objectives and targets for the purpose of certification. Some of the important environmental objectives established included: reducing the water consumption, reducing chemical wastage, sorting and disposing of solid waste.

The top management also defined the environmental roles and responsibilities covering the environmental management functions and other operational areas of the organisation. In addition to the responsibility of EMS objectives and targets, specific people were identified for the activities of the environmental management system, as quantifiable and measurable environmental targets were necessary to demonstrate progress in making environmental improvements within a given time frame.

Next, it was necessary to develop the Environmental Management System manual. The EMS manual was the central document of the company's EMS. The manual was prepared in accordance with the ISO 14001 requirements and was linked to 24 Environmental Procedures and 84 Environmental Records.

2.4.4 Certification of the EMS

The main objective of third-party certification was for the company to meet the expectations of its customers in the global market, particularly those from Europe and the USA. To be certified to ISO 14001, the company had to undergo a third-party audit carried out by an accredited certification body. Prior to this audit, the company performed internal audits to review its current environmental practices and compare those practices with the requirements of the ISO 14001 standards. The audit objectives also included both the progress in achieving the environmental objectives and targets set for different processes a check on compliance with, regulatory requirements. The audits were conducted by trained auditors independent of the areas being audited. The deficiencies identified by the internal audits were rectified through appropriate corrective action.

During the implementation, the company received assistance from two foreign consultants under a free consultancy programme sponsored by the UNIDO and Ministry of Industries, although financial assistance was not a deciding factor in obtaining certification. It took one and half years to develop the EMS and according to the Environmental Management Representative, top management commitment was the critical success factor for implementation of ISO 14001 at BFL. In addition, the company has given EMS awareness training to approximately 75% of its employees and, in fact, two of them are qualified Lead Auditors now. The company obtained ISO 14001 certification in 2002 from

RWTÜV, a German certification body accredited by the Technical Inspection Authority (TÜV); at the time, certification from an international certification body was believed to have more credibility. Brandix Finishing Ltd. (formally Finitex Textile Finishing Ltd.) was the first garment dyeing and finishing facility to be certified in South Asia.

2.4.5 Benefits perceived by the company

The benefits perceived by BFL are similar to those found in the literature on ISO 14001 implementation and certification (Please also see Section 2.3.4):

- Improvement of environmental performance
- Cost and waste reduction
- Increased access to global market
- Increased operational efficiency
- Better utilisation of materials and resources
- Facilitating compliance with legal requirements
- Assurance to the interested parties
- Increased employee participation and awareness

In more specific terms, the company has managed to improve the environmental performance by way of achieving 90% COD and BOD removal efficiency, and reduction of sulphur dioxide, nitrogen dioxide, suspended particle matter, and carbon monoxide emissions from the plant. There have been significant reductions in water consumption and steam energy consumption over the last few years, which in turn has resulted in a reduction of operational costs. Proper solid waste deposal, which is supported by the 5-S system, has become a new way of generating extra revenue for the company. New markets have increased annual turnover; so profitability is achieved manly through the increase in overall production efficiency. The total investment for the implementation was about US$5,000 in 2002, and as result of systematic environmental management through the EMS, the annual cost savings alone are around US$ 93,000.

The company is well recognised by its community for the efforts made in protection of the environment. Just two years after the implementation of the ISO 14001 EMS, the company received the President's Environmental Award for Environmental Excellence in the Industrial Sector for the year 2004, and also, it won the CIMA Community Leader Award for the Best Practices towards Waste Minimisation in 2005.

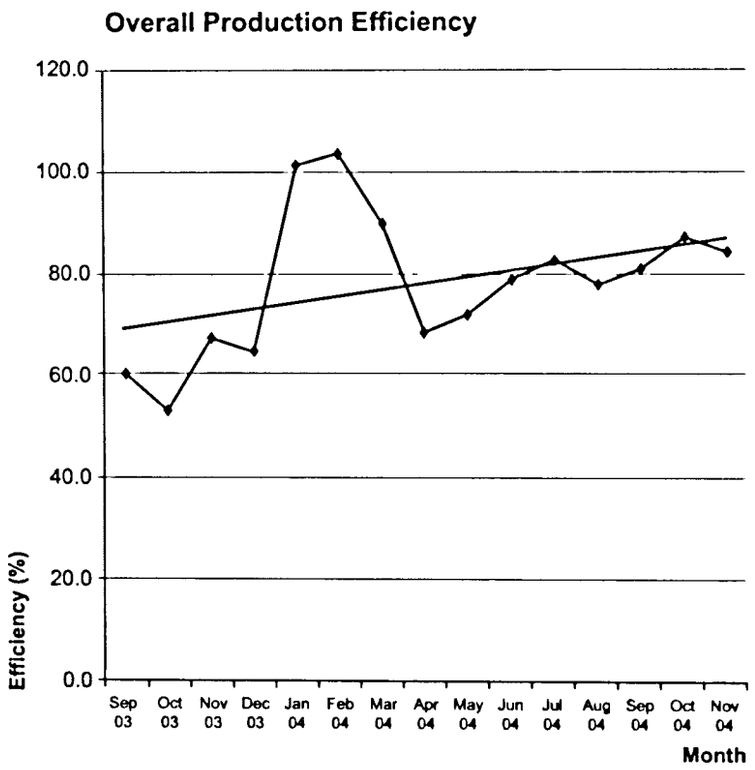


Figure: Increased Efficiency - Brandix Finishing Ltd. (©Brandix Finishing Ltd.)

2.5 Diffusion of ISO 14000 standard

2.5.1 Worldwide certification

The world wide distribution of ISO 14000 certification shows that its greatest growth has been in Europe and the Far East with Japan having the highest number of certified organisations. In terms of industrial sector, the highest numbers of certifications are in electrical and optical equipment sectors followed by the chemicals, chemical products and fibres sectors (Environment and Labour, 2004, p.2). However, the implementation of the ISO 14001 standard is not limited to the industrial sector; educational institutions (Fisher, 2003, p.144), defence organisations and shipping lines (Sharpe, no date, p.5) are good examples for this. By 2002, the number of ISO 14001 certificates awarded to companies in 118 countries worldwide stood at 49,462 (Angle and Rock, 2004, p.12). China, the home of some 20% of the world population, has already

adopted ISO 14000 as state policy (Graff, 1997, p.21). In China, the rate of ISO 14000 certification was higher among plants operated by MNCs and those owned by local companies exporting to OECD economies (Angle and Rock, 2004, p.12). In the year 2000, Japan had the single largest concentration of certificates (3,318) in the world; together with Germany and the United Kingdom, it accounted for almost half the total certifications (Singh and Perry, 2000, p.270). By January 2006, the situation had changed with Japan still at number one position (over 19,000 certifications) and China advancing to the second place (12,683 certifications). There are over 103,500 companies in about 140 countries certified to the ISO 14001 standard; of these, the top ten countries account for more than 70% of all the certifications in the world (CRM, 2006, p.1-2). They include Japan, China, Spain, Italy, United States of America, Germany, Korea, Sweden and the Czech Republic.

This popularity of ISO 14001 certification is partly due to its recognition by influential companies in some industries such as the multinational companies (MNC) in the automobile industry (Gonzalez-Benito and Gonzalez-Benito, 2005, p.134). For example, Ford motors achieved ISO 14001 certification for all of its more than 140 plants located across the globe between 1996 and 1998 (Eisner, 2004, p.150). Further, the company stipulated that all of its suppliers should certify at least one manufacturing site to ISO 14001 by the end of 2001 and all manufacturing sites supplying products to the company by the middle of 2003.

Following Ford's initiatives, other motor companies such as General Motors, Daimler Chrysler, Toyota and Honda have now imposed similar requirements. Both Ford and General Motors have asked their facilities to establish an EMS, which follows a common structure (Mathews, 2003, p.96). Now, almost all automobile manufacturing companies in the United States are moving towards ISO 14001 certifications; for example, Honda requires all of its major plants worldwide to be certified to ISO 14001 (Potoski and Prakash, 2005, p.238).

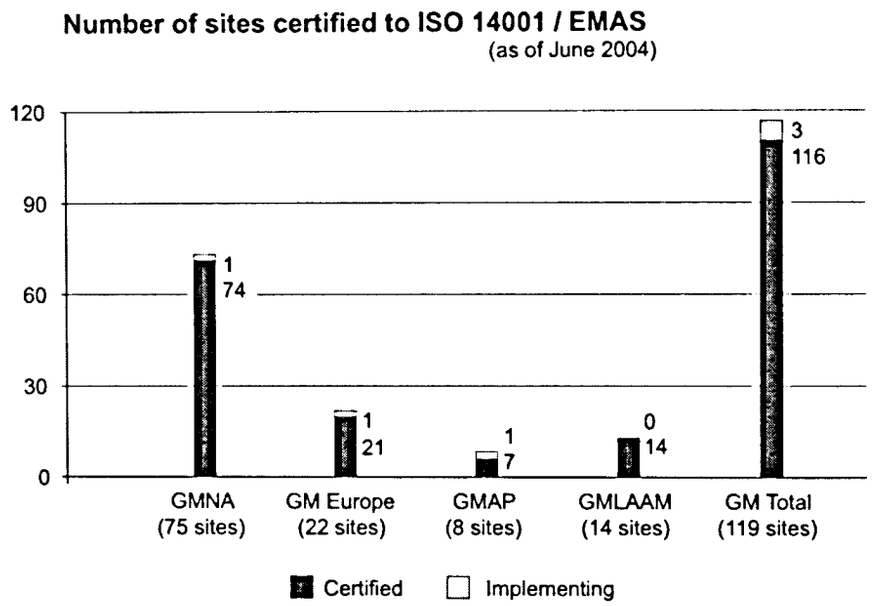


Figure: Worldwide EMS implementation by General Motors (Source: www.gm.com)

2.5.2 ISO 14000 in developing countries

For developing countries, the environmental pressures usually come through the supplier chain: the multinational companies requiring smaller national suppliers to achieve and demonstrate environmental performance improvements (World Bank, 1998, p.133).

It is believed that companies in developing countries could face some cost disadvantages, as a result of the implementation of ISO 14000. First, the standard describes a management system that is more in line with contemporary management systems in the developed countries. Second, the collection of information on applicable laws and regulations in developed countries is relatively cheaper. Third, the identification of environmental aspects and impacts, which is a key requirement in the development and implementation of an EMS, could involve significance expenses for companies in developing countries (UNCTAD, 1997, p.7). Some consider that additional costs incurred, ISO 14001 certification could adversely affect the competitiveness of companies in developing countries.
It is also believed that this type of standard may force companies in developing countries to choose between competition in international markets based on non-price factors or to confine themselves to price-based competition in

market segments that are less attractive in terms of demand and profit (Chudnovsky and Lopez, 1999, p.12).

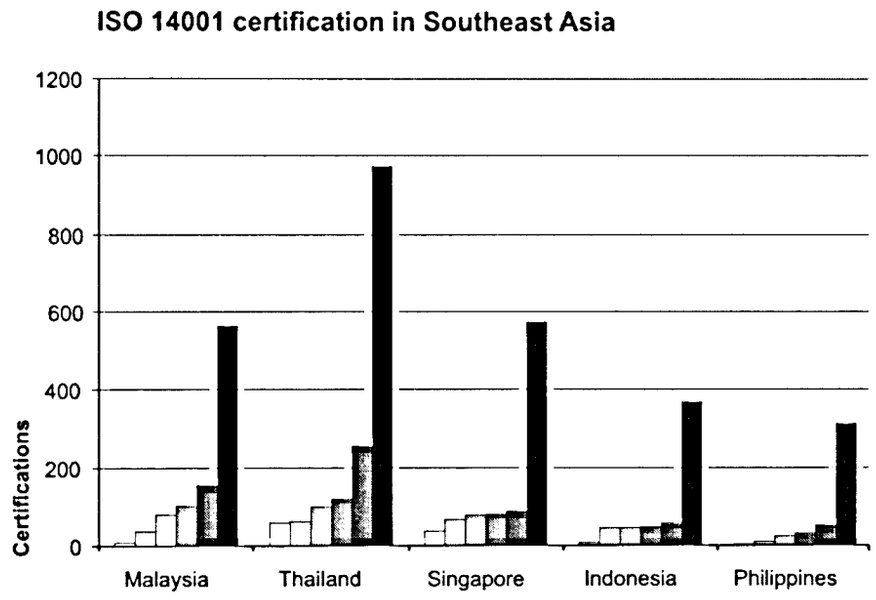


Figure: ISO 14001 certification in Southeast Asia (Source: Singh and Perry, 2000, p.270: www.ecology.org)

The opinion that ISO 14000 would become an essential passport for developing countries to do business with the international markets is rejected by organisations such as the World Bank (1998, p.133). However, ISO 14001 could become a non-tariff barrier to trade (NBT) (although the basic objectives of ISO are quite the opposite), or alternatively the standard might provide a competitive advantage for certified companies. The companies could attempt to overcome this problem by going for self-declaration; although this is possible with ISO 14001, for many companies in developing countries, third party certification may be essential to gain credibility in the marketplace. One consolation is that the certification costs involved with local ISO certification bodies in developing countries tend to be much lower than in developing countries(UNCTAD 1997, p.9).

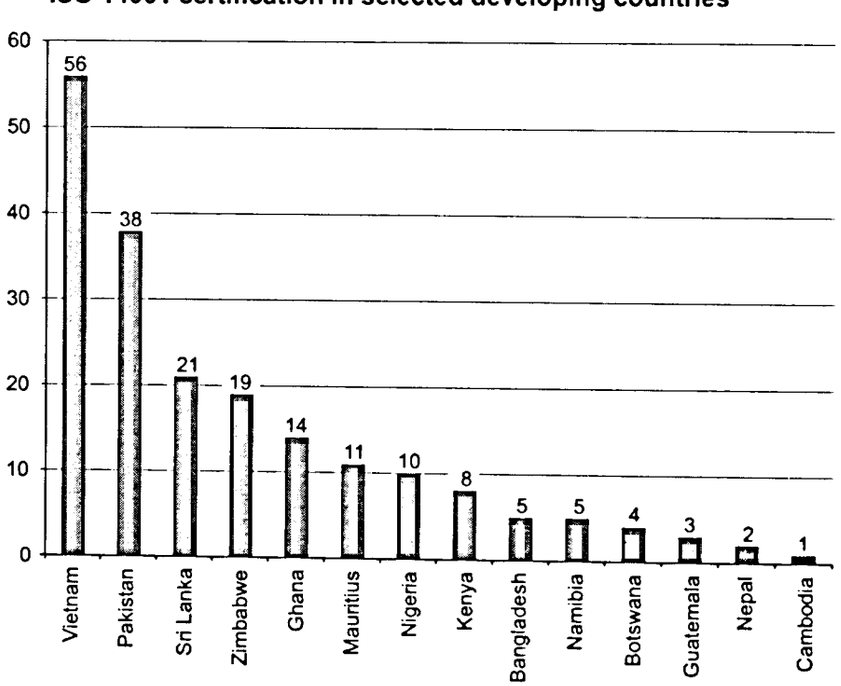


Figure: ISO 14001 certification in selected developing countries (Source: www.ecology.org)

The international values of ISO certification would, however, depend on the confidence the customers have in the certifying body. Although, there are only few, there have been cases of non-acceptance of ISO certificates issued by certifying bodies in developing countries (Chudnovsky and Lopez, 1999, p.12). However, the low costs of local certifying bodies in developing countries is a deciding factor and the mutual recognition of certification bodies could be very useful in order to avoid ISO 14001 certification becoming a possible trade barrier for companies in developing countries (Chudnovsky and Lopez, 1999, p.12).

2.5.3 Environmental Legislation and ISO 14000

Environmental legislation is a common requirement in almost every country in the world (Quazi, 1999, p.306). It covers areas such as: atmospheric emissions into the air, liquid effluent, solid waste, dust and noise. For example, in Germany there are about 800 laws and 2,800 ordinances related to environmental

protection (Watson and Emery, 2004, p.916); if state laws are also considered, the figure could be as high as 35,000 (Wurzel et al., 2003, p.117-120).
In the past, environmental performance was measured in terms of the degree of compliance with the regulations (Rothenberg et al, 2005, p.10), which was also known as the 'Command and control' approach (Irvin, 2002, p.360). Such command and control measures typically include performance standards and procedures that are monitored and enforced by regulatory agencies (Singh and Perry, 2000, p. 269). Those who do not conform to these have to face severe financial and/or criminal penalties.

Although, previous research in the industry demonstrates that regulations matter a great deal in influencing or 'shaping' the behaviour of companies with respect to environmental management (Kagan et al., 2003, p.82), there are some shortcomings related to the above 'command and control' approach:

- Industrial accidents, particularly those with significant human and environmental harm, have proven that laws and regulations are not enough to ensure environmental protection (Georgiadou and Tsiotras, 1998, p.287).
- Environmental legislation often gives governing authorities (regulators) the necessary power to rectify environmental damage caused by polluters. The cost of such rectification could be several times higher than the ultimate fine (Watson and Emery, 2003, p.667).
- According to Environment Agency officers, adverse publicity is more effective in dealing with polluters than fining them (De Prez, 2000, p.13). This is because most companies take their corporate image very seriously when it comes to environmental protection (Watson and Emery, 2003, p.667).
- Once the standards given in the regulations are achieved, there is no incentive for a company to improve its environmental performance beyond the requirements of the standards.
- Other factors such as social pressures appear to be more powerful than regulations in encouraging companies to go beyond compliance in remedying environmental impacts that disturb their neighbours or in protecting the environment.

Therefore, voluntary environmental initiatives such as ISO 14000 have been proposed as an alternative approach to old, rigid "command and control" systems within companies (Black, 1998, p.25) in order to overcome the problems of high costs and inadequate enforcement and monitoring. Some advantages of ISO 14000 EMS over the 'command and control' approach are listed below:

- Environmental management practices of companies certified to ISO 14001 are better positioned to meet regulatory requirements (Begley, 1996, p.51).
- In some countries, the use of ISO 14001 certification has helped companies to be exempted from the statutory reporting requirements with respect to environmental performance (World Bank, 1998, p.132).

- A properly implemented EMS not only assists companies to ensure that their performance is within the regulatory requirements, but also stays ahead of more stringent regulations, which might be introduced in the future (Chavan, 2005, p.448).
- Not only the ISO 14001 could not only assist a company as a proactive approach that reduces risk of violating these laws, but also demonstrate its commitment to the environment, which in turn, could place the company in a favourable position when liabilities are determined in the case of an environmental offence.

However, in competitive industries, economic pressures limit how far even most environmentally committed companies can go in this direction; government intervention seems necessary in such situations.

2.5.4 Role played by governments

The role played by the government in implementing EMS in companies could be vital and often could be in the form of providing information, establishing the necessary infrastructure and helping companies to develop the basic capabilities to adopt ISO 14000 (World Bank, 1998, p.134). In more specific terms, providing information on the sectors and markets when ISO 14001 certification is a significant issue and assisting sector organisation to develop appropriate responses could be quite useful. Also strengthening the national standard organisation (NSO) and certification service are important. Many countries have adopted the ISO 14000 as a government policy, with one example being, China (Graff, 1997, p.21). As the ISO 14000 standards are voluntary, their 'adoption' by a country only means that it is the EMS standard that is recognised by the standards organisation (NSO); it does not, however, mean that all companies in the country should adopt the ISO standard as a formal requirement (World Bank, 1998, p.131). For such initiative to be effective, the broad environmental strategy of a government could also include regulatory systems, appropriate financial incentives, and encouragement of improved industrial performance. It is believed that such encouragement can only be effective if there is proper co-operation between relevant government agencies responsible for industry, trade and environment (World Bank, 1998, p. 131).

As implementation of ISO 14001 is essentially a voluntary initiative, every company in a particular industry cannot be expected to adopt it. However, if the government intervenes through necessary regulations, the ISO 14000 standard can become an effective tool in protecting the environment (Chavan, 2005, p.448); Germany and Austria are excellent examples of this. On the other hand, countries with less stringent environmental regulations usually have fewer companies certified to the standard; Flynn (2003, p.138) cites Ireland as an example. Provision of incentives for companies with excellent environmental performance is another way the government can encourage increased adoption of the standard. In some countries there are government incentives to imple-ment ISO 14001 standards.
For example, under the Local Enterprise Technical Assistance Scheme (LETAS), Singaporean companies can apply for a grant of 70% of the consultancy cost in obtaining ISO 14001, subject to a maximum of $40,000 (Singh and Perry, 2000, p.274). The financial incentives offered to SMEs in Nordic countries (Denmark, Finland, Norway and Sweden) for the implementation of EMS such as ISO 14001 is another excellent example Clement and Hansen, 2002, p.76).

Environmental incentives available for SMEs in the Nordic countries

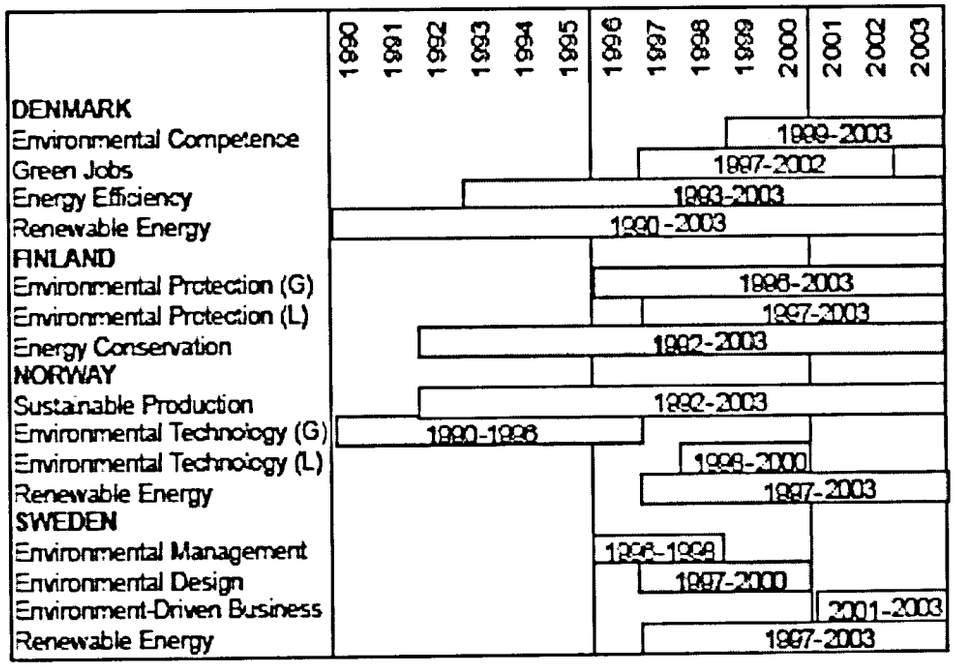


Figure: Environmental incentives available for SMEs in the Nordic countries (Source: Clement and Hansen, 2002, p.78)

3 Concluding remarks

The aim of this lecture was to provide the students with knowledge regarding the implementation of the ISO 14000 environmental management system (EMS). In doing so the author has limited the discussion to an overview of the subject with particular emphasis on a few important aspects: reasons for implementation of the EMS; costs and benefits of certification; critical success factors for implementation; impediments of ISO 14000; and integrated management systems. To supplement the above discussion, the author has used a case study of an ISO certified company in the textile industry, where environmental management has become an essential business issue. The students would have found in the text that companies who have successfully implemented their EMS in accordance with ISO 14000 provide excellent examples as to how well-formulated environmental strategies could lead to business advantages such as better quality, reduced costs, improved company image, relations with customers and opening of new markets. It should be noted, however, that the level of business interest in the environment and associated action can change enormously from one company to another (Pun et al., 2002, p.692). Due to this, the adoption of EMS in many companies may not necessarily lead to an enhanced competitive advantage and other benefits. There is a need, therefore, to align the planning of the EMS with corporate objectives and identify most critical or important environmental processes and procedures that lead to long-term benefits. Finally, the students are encouraged to explore the subject area using the resources given at the end of the lecture and the Internet to learn more about the environmental aspects relevant to different types of industries and their impacts, the future challenges faced by individuals and as well as organisations in relation to consequential environmental hazards, and how effective ISO 14000 would be in dealing with such challenges.

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5 Glossary

5-S system
The 5-S system is a technique to organise the work place, to keep it neat and clean, to maintain the discipline necessary to do a good job. These are: Seiri (Sorting out); Seiton (Systematic Arrangement); Seiso (Shine); Seiketsu (Standardize); and Shitsuke (Self-discipline).

Accredited
Holding formal recognition following successful accreditation. See also Accreditation of certification bodies.

Assessment
An estimate or determination of the significance, importance, or value of something. (www.iso14.vintara.com)

Assessor
Same as Auditor.

Audit
Systematic, independent and documented process for obtaining evidence and evaluating it objectively to determine the extent to which requirements are fulfilled. (ISO 9000, 2000, clause 3.9.1)

Auditor
Person performing an Audit.

BOD (Biochemical Oxygen Demand)
A measure of the amount of oxygen consumed in the biological processes that break down organic matter in water. The greater the BOD, the greater the degree of pollution. (www.epa.gov)

BS 5750
British standard for quality management.

BS 7750
British standard for environmental management.

Certification
Procedure by which a third party gives written assurance that a product or process conforms to specified requirements. (De Vries, 1999, p.xix)

Certification body
An organisation which has received accreditation to perform certification on other organisations as an impartial third party.

Certified
State of having received certification.

CIMA
Chartered Institute of Management Accountants.

COD (Chemical Oxygen Demand)
A measure of the oxygen required to oxidise all compounds, both organic and inorganic, in water. The greater the COD, the greater the degree of pollution. (www.epa.gov)

Competitive advantage
The advantage a company has over other competitors in the same market, in terms of factors such as high quality of products, low cost of production, sound technology, customer relationships, installed base, and efficient distribution channels.

Compliance
An affirmative indication or judgement that the supplier of a product or service has met the requirements of the relevant specifications, contract, or regulation. (www.iso14.vintara.com)

Continual improvement
Process of enhancing the Environmental Management System (EMS) to achieve improvements in overall performance, in line with the organisation's environmental policy. (ISO 14001, 1996, p.1)

Corporate culture
A system of values, beliefs, and behaviours inherent in a company. (www.tncpe.org)

Corporate Social Responsibility (CSR)
An organisation's obligation to conduct business in such a way as to safeguard the welfare of society while pursuing its own interests. (Schylander, 2004, p.vii; Holt and Wigginton, 2002)

Corrective action
An action taken to eliminate the causes of an existing nonconformity, defect, deficiency, or other undesirable situation in order to prevent recurrence. (www.iso14.vintara.com)

Cradle to grave
A term used to describe the entire life-cycle of a product or service.

Critical success factors (CSF)
Factors that are essential for the successful implementation or performance of some activity.

Deficiency/Deficiencies
A product's or service's non-fulfilment of an intended requirement or reasonable expectation for use, including safety considerations.

Eco Management and Audit Scheme (EMAS)
Environmental management standard developed by the EU Commission, now an EU regulation; EMAS differs from ISO 14001 in that public disclosure in the form of environmental reporting is compulsory. (www.balticuniv.uu.se)

Effects
Refers to changes, actual or potential, caused by a chemical, activity, or process as it comes into contact with humans or the environment. (iso14.vintara.com)

Effluent
Wastewater -treated or untreated- that flows out of a treatment plant, sewer, or industrial outfall. Generally refers to wastes discharged into surface waters. (www.epa.gov)

Emissions
Pollution discharged into the atmosphere from smokestacks, other vents, and surface areas of commercial or industrial facilities; from residential chimneys; and from motor vehicle, locomotive, or aircraft exhausts. (www.epa.gov)

Environment
Surroundings in which an organisation operates, including air, water, land, natural resources, flora, fauna, humans, and their interrelation. (ISO 14001,1996, clause 3.2)

Environmental aspect
Element of an organisation's activities, products, and services that can interact with the environment. (ISO 14001,1996, clause 3.3)

Environmental assessment
A systematic, documented, periodic and objective review by company management of facility operations and practices related to meeting environmental requirements. The assessment is a systematic, documented verification process of objectively obtaining and evaluating evidence to determine whether specified environmental activities, events, conditions, management systems, or information about these matters conform with selected criteria, and communicating the results of this process to management. (iso14.vintara.com)

Environmental impact
Any change to the environment, whether adverse or beneficial, wholly or partially resulting from an organisation's activities, products or services. (ISO 14001, 1996, clause 3.4)

Environmental management
According to the United Nations Environment Programme (UNEP), environmental management is controlling all human activities that have significant impact on the environment (Rowland- Jones et al., 2005, p.217). It involves all actions required to minimise adverse environmental impact of a company's product or services through out the entire life cycle: from 'cradle to grave' (Zsidisin and Hendrick, 1998, p.313).

Environmental Management System (EMS)
An EMS is that part of the overall management system which includes the organisational structure, responsibilities, practices, procedures, processes, and

resources for developing, implementing, achieving, reviewing, and maintaining the environmental policy. (ISO 14001, 1996, clause 3.5)

Environmental objective
Overall environmental goal, arising from the environmental policy, that an organisation sets itself to achieve, and that is quantified where practicable. (ISO 14001, 1996, clause 3.7)

Environmental performance
The measurable results of the environmental management system, related to an organisation's control of its environmental aspects, based on its environmental policy, objectives, and targets. (ISO 14001, 1996, clause 3.8)

Environmental policy
Statement by the organisation of its intentions and principles in relation to its overall environmental performance, which provides a framework for action and for the setting of its environmental objectives and targets. (ISO 14001, 1996, clause 3.9)

Environmental Statement
A publicly available, written statement of an organisation's intention to achieve continual improvement in environmental performance. When verified by the accredited third party, it acts as a main criterion of EMAS. (GPG, 1998, p.61)

Environmental target
Detailed performance requirement, quantified wherever practicable, applicable to the organisation or parts thereof, that arises from the environmental objectives and that needs to be set and met in order to achieve those objectives. (ISO 14001, 1996, clause 3.10)

EPL
Environmental Protection Licence - This is a regulation, made under the National Environmental Act of Sri Lanka, requiring companies to obtain permission to carry out 125 prescribed activities.

Gap analysis
This reviews the existing environmental practices and the requirements of the ISO 14000 standards in order to identify any gaps.

Hazard
The ability to cause damage.

Integration
Integration refers to the degree of alignment or harmony in an organisation - whether different departments and levels speak the same language and are tuned to the same wavelength. (Garvin, 1991, p.87)

Interested party
Individual or group concerned with or affected by the environmental performance of an organisation. (ISO 14001, 1996, clause 3.11)

Internal audit
An Audit carried out by an organisation on its own; also known as 'First party audit' or 'Self-audit'.

ISO 14000 series
The series of environmental management standards published by the ISO.

ISO 14001
Environmental management standard published by ISO.

ISO 9000 series
The series of quality management standards published by ISO.

ISO 9001
The main quality management systems standard published by ISO.

Life cycle
Consecutive and inter-linked stages of a product system, from raw material acquisition or generation of natural resources to the final disposal. (iso14.vintara.com)

Life-cycle assessment (LCA)
Compilation and evaluation, according to a systematic set of procedures, of the inputs and outputs of materials and energy and the potential environmental impacts of a product system throughout its life cycle. (iso14.vintara.com)

MNC
Multinational company - a company which has operations in more than one country.

NEA
National Environmental Act - This governs environmental legislation in Sri Lanka. The Act became effective in 1980 and has subsequently been amended twice in 1988 and 2000.

OECD
Organisation for Economic Co-operation and Development. The OECD is a group of 30 countries sharing a commitment to democratic government and the market economy. With active relationships with some 70 other countries, NGOs and civil society, it has a global reach. Best known for its publications and its statistics, its work covers economic and social issues from macroeconomics, to trade, education, development and science and innovation. (www.oecd.org)

Performance indicator
A relationship describing environmental performance such as emissions per unit of production, for instance.

Plan-Do-Check-Act (PDCA) cycle
A four-step process for environmental improvement. In the first step (plan), a plan to effect improvement is developed. In the second step (do), the plan is carried out, preferably on a small scale. In the third step (check), the effects of the plan are observed. In the last step (act), the results are studied to determine what was learned and what can be predicted. The plan-do-check-act cycle is a concept introduced by W. Edwards Deming in Japan, where it was subsequently called it the Deming cycle. Adopted from: www.tncpe.org .

Prevention of pollution
Use of processes, practices, materials, or products that avoid, reduce or control pollution, which may include recycling, treatment, process changes, control mechanisms, efficient use of resources and materials substitutions. (ISO 14001, 1996, clause 3.13)

Procedure
A specified way to perform an activity.

Process
A set of interrelated resources and activities that transform inputs into outputs. (ISO 9000, 2005, p.8)

Product
Any good or service.

Quality Management Systems (QMS)
A management system to direct and control an organisation with regard to quality. (ISO 9001, 2000)

Registered
Same as Certified.

Registration
Same as Certification.

Responsible Care
The Responsible Care programme of the American Chemistry Council is a self-regulation system used to regulate its members with the objective of minimising potential environmental impacts in the chemical industry.

Self-regulation
Self-regulation is used to describe efforts made by industry associations to regulate the actions of their members. This is different to voluntary schemes such as ISO 14000, which is implemented on a company-specific basis. (Eisner, 2004, p.159)

Significant environmental aspect
An environmental aspect that has or can have a significant environmental impact. (ISO 14001, 1996, clause 3.3)

SME
Small and medium-sized enterprise or company having less than 250 employees (Definition could vary from one country to another).

Strategy/strategies
This is a more long-term-oriented concept involving not only the short-term tactics, but also a broader definition of the ways that have to be followed in order to achieve long-term objectives.

Surveillance audit
Audits performed by the certification body on a certified organisation at a regular interval (usually annually) within the validity period of the certification (usually three years).

Sustainability
This is using no more natural resources than the natural environment can re-generate. (Stainer and Stainer, 1997, p.226)

Sustainable development
Sustainable development can be defined as providing products and services to meet the needs of current generations without compromising the ability of future generators to meet their own needs. (Graff, 1997, p.21)

Third-party audit
Audit performed by a certification body.

Top management commitment
Participation of the highest-level officials in their organisation's environmental improvement efforts. Their participation includes establishing and serving on a steering committee, establishing environmental policies, objectives, and targets, deploying those objectives to lower levels of the organisation, providing the resources and training that the lower levels need to achieve the target objectives, participating in environment improvement teams, reviewing progress organisation-wide; recognising those who have performed well, and revising the current reward system to reflect the importance of achieving the environmental objectives. Adopted from: www.tncpe.org .

TQM
A term initially coined by the Naval Air Systems Command to describe its Japanese-style management approach to quality improvement. Since then, total quality management (TQM) has taken on many meanings. Simply put, TQM is a management approach to long-term success through customer satisfaction. TQM is based on the participation of all members of an organisation in improving processes, products, services, and the culture they work in. TQM benefits all organisation members and society. The methods for implementing this approach are found in the teachings of such quality leaders as Philip B. Crosby, W. Edwards Deming, Armand V. Feigenbaum, Kaoru Ishikawa, and J. M. Juran. (www.asq.org)

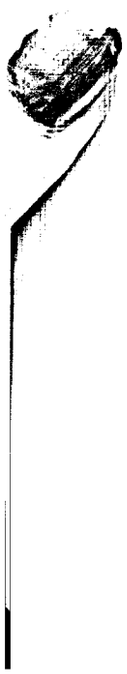
UNIDO
United Nations Industrial Development Organisation. Its vision is to improve the living conditions of people and promote global prosperity through offering tailor-made solutions for the sustainable industrial development of developing countries and countries with economies in transition. (www.unido.org)

Waste
Any output from the product system that is disposed of. (www.iso14.vintara.com)

Work instructions
Step-by-step instructions given to perform a specified activity; work instructions are usually given as supplementary documents to Procedures.

6 Key questions

- What is the purpose of an Environmental Management System established in an organisation?
- What are the areas covered by the main standards in the ISO 14000 series?
- What is ISO 14001 certification and how can an organisation obtain this?
- The following steps could be followed by an organisation to obtain ISO certification:
- What are the main differences between the Eco Management and Audit Scheme (EMAS) and the ISO 14001 environmental management system?
- What are the main motivations or reasons for the ISO 14001 implementation and certification?
- Why is the 'Top Management Commitment' so important in the implementation of an ISO 14001 Environmental Management System?
- What differences does a company need to consider in integrating the ISO 9000 quality management system and the ISO 14000 environmental management system?
- What is the current situation with respect to ISO 14001 certification in the world?
- What are the difficulties faced by companies in developing countries in implementing the ISO 14001 standard?
- What is the role that governments can play in implementing ISO 14001 environmental management systems in companies?



Mingshun Song · Yufan Diao · Hongkuan Wu

Abstract

This lecture considers the Shangpan broccoli industry, Linhai City, Zhejiang Province as an example of agricultural standardization in China. In a comparison of the situations before and after adopting international standards, it is shown that standards show a positive effect on agricultural production and processing. The gap between the requirements of international standardization and the knowledge and technology of local farmers is introduced in Chapter 1 with the example of Zhejiang Province. Chapter 2 describes the pre-standardization situation, including production, problems and economic losses in the broccoli industry. Chapter 3 analyses how problems of the broccoli industry have been solved by standards set by the Cooperative. Chapter 4 describes the situation after standardization. Chapter 5 states economic theory and provides a qualitative analysis of the standardized Cooperative. Concluding remarks are made in Chapter 6.

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1 Preface

Owing to lower prices, more and more Chinese agricultural products, especially vegetables, are being exported to developed countries. Farmers in developing countries use pesticides and fertilizers in an uncontrolled manner during production because they lacked an awareness of scientific technology, agricultural industrialization, and standardization. The quality of agricultural products therefore often fails to meet international standards, such as the CAC standards. This serious issue causes large economic losses. How can millions of poorly educated farmers, who have little knowledge of scientific technology, and who operate independently produce low-cost agricultural products comply with international standards? Most developing countries face this common problem. The standardized production mode of Shangpan broccoli provides a suitable case for solving this problem.

2 Pre-standardization situation of the broccoli industry

2.1 Description of the broccoli industry

Broccoli is one of the most popular vegetables in Japan. In 1989, broccoli plants were imported from Japan to Shangpan and cultivated successfully. Because of the lower labour costs in Shangpan, the price of Shangpan broccoli was half that in Japan. A large number of Japanese importers began to import broccoli from Shangpan, which led to the expansion of planting areas and increased production volume. Japan became the main destination for broccoli exports. Owing to the special geographical conditions and promotion by the local government, the broccoli-planting industry developed vigorously. The cultivated area amounted to over 70,000 hectares, and the town became the largest producer in China. Furthermore, related industries for broccoli processing, packaging and transportation also emerged. Twelve of these processing enterprises became the main sources for increasing local farmers' income.

2.2 The situation of broccoli production before standardization

2.2.1 The situation of farmers

The farmers in Shangpan planted broccoli independently without any instruction before 2002. Companies purchased broccoli during the harvest and exported it to Japan. Every farmer had a plot of 0.162 hectares to cultivate. During planting, they utilized pesticides and fertilizers at random. They generally selected fertilizers of a lower price and higher efficiency, with heavy metals and toxic residues. They had no standards as to when, how and in what quantity to apply these fertilizers and pesticides. Nor were they concerned with the quality and safety of agricultural products.

2.2.2 The situation of the processing enterprises

Most processing enterprises were not aware of any standards in the processing of broccoli. They controlled the processing on the basis of their experience and followed no specifications or quality-control standards when protecting their crops and dealing with polluted water and heavy metal contamination. In some enterprises, the processing equipment was so simple that it was only minimally capable of carrying out disinfection, watering, and clearing procedures. Most processing companies had no measuring equipment and did not even inspect the broccoli plants. They had no idea whether or not the broccoli exported was up to standard. Consequently, the quality of broccoli production was out of control.

However, there were a few processing enterprises that had better processing conditions with advanced equipment, thorough work processes and processing norms, and detailed standards and measures of quality control. They disinfected, cleaned, and decontaminated broccoli strictly according to international standards. Measuring equipment and instructions were calibrated on the basis of metrological standards, and these enterprises inspected their products in line with the requirements of international standards. But they did not purchase the farmers' products. They had their own plots of land with areas of 10 to 60 hectares. They used pesticides and fertilizers according to international standards and processed the broccoli harvested from their own farmland. Quality of the products could thus be guaranteed. But their land could not be expanded, and therefore product quantities and processing volumes could not be increased. They did not want to purchase the farmers' products, which were not in compliance with standards and the quality of which could not be guaranteed. Hence, the planting, processing, and management abilities of these excellent processing enterprises could not be fully exploited to gain more economic benefits.

2.3 The problems in the broccoli industry

In April 2002, Japanese customs authorities, in sampling the broccoli imported from Shangpan, found that the primary pesticide residues in all of the broccoli inspected exceeded the CAC standards. Without adopting any standards, farmers and enterprises were using pesticides and chemical fertilizers at random and were not paying any attention to hygiene conditions during processing. Finally, the fatal crisis of Shangpan broccoli happened. During an examination of the products exported to Japan, the pesticide residues and heavy metal contents were found to seriously exceed the limits of the international standards or the CAC standards.

On average the pesticide residues exceeded the CAC standards (e.g. Acephate 2 MRL, Diazinon 0.5 MRL, Terbufos 0.05 MRL) by 200% (for example, aluminium by 150% and cadmium by 250%). As a result, Japan adopted stricter measures of quality inspection. The inspection was changed from random sampling to 100% inspection of all products. The number of inspection items for broccoli was increased from 6 to 43, and inspection costs increased by 450%.

2.4 Economic losses in the broccoli industry

The Shangpan broccoli industry, which mainly exported to Japan, suffered heavy losses because of the changed standards and increased inspection charges. Large amounts of broccoli were overstocked and unsold. For the expansion of inspection criteria, broccoli inspection was expanded to cover all products. Inspection charges for Shangpan broccoli exported to Japan were 450% higher than before. Moreover, the requirements for many inspection criteria were stricter than those of the CAC standards, which made it difficult for the products of many processing enterprises to meet the new requirements.

Most farmers could not afford the export expenditure. So they decreased their production and turned to the domestic market. Being regarded as unqualified goods, many products produced by those farmers who were able to export their products were returned and destroyed. Consequently, the heavy losses suffered by the broccoli industry of Shangpan were as follows: yields decreased by 50%; the unit price dropped from 0.8 CNY to 0.2 CNY; and direct economic losses doubled. In short, broccoli production was in a difficult position.

3 The solution to the broccoli industry problems

3.1 Establishment of the Cooperative

Because of serious economic losses, the farmers and the processing enterprises clearly realized that they needed to adopt quality-control standards and operational norms in the process of either planting or processing. They recognized the need for products to meet the relevant requirements of the CAC standards and that some standards and norms should be followed in the management of production. This included changes in: seed selection, seedling cultivation, land preparation, irrigation, pesticide utilization, fertilizer application, plant protection, harvesting, etc. The stages of processing were also required to meet the demands of HACCP. In this way, the quality of products could be controlled throughout the process. The farmers did not know how to draft standards and had no technology or expertise available, so it was impossible for them to formulate standards by themselves. Most processing enterprises had no ability to formulate standards either but the Shangpan broccoli industry urgently needed relevant, unified standards.

A few processing enterprises with a large processing capacity and skilled labour were able to set planting standards and broccoli processing standards. They also wanted to help farmers use planting standards correctly with their technology and skills. In this way, farmers' products could be assured of meeting the requirements of the CAC standards. This would improve the enterprises' processing ability and use their technological and market advantages to full effect. They would also be able to increase the scale of their operations to cover shortfalls in processing capacity caused by land shortages. A cooperative organization, which would bring advantages through the sharing of resources, was urgently needed. Due to common demands and a willingness to change the situation, the Shangpan Broccoli Agricultural Cooperative was set up to coordinate all these requirements.

3.2 The Cooperative structure

The Shangpan Broccoli Agricultural Cooperative was set up on 28 June 2002, as a share-holding cooperative managed by the industry and operated on entrepreneurial principles. Led by the local government, it was founded by four leading enterprises (e.g. Yilong Corp.) and a sales enterprise and was driven by planting, processing, circulation, and scientific research and service organizations.

Currently, the 857 members of the Cooperative are divided into three levels. The first level is made up of 12 processing enterprises with a registered capital of 14 million CNY. Their environment-friendly crop demonstration

fields cover more than 100 hectares with 3,750,000 square metres of buildings, 5,500 square metres of refrigeration facilities and a working capacity of 2.14 billion kilograms per year that can process products from 40,000 hectares of cultivated land. The second level is made up of ten marketing corporations and an ancillary service organization. The third level is made up of 834 farmers planting 55,000 hectares of cultivated land distributed over 5 counties and cities and divided into 16 branches and 81 operation areas. The structural chart of the Cooperative is shown in the figure that follows. The Cooperative set up the following executive offices: Marketing Department; Scientific and Technological Service Department; Food Processing Department; and the Administrative Office.

The Cooperative structure

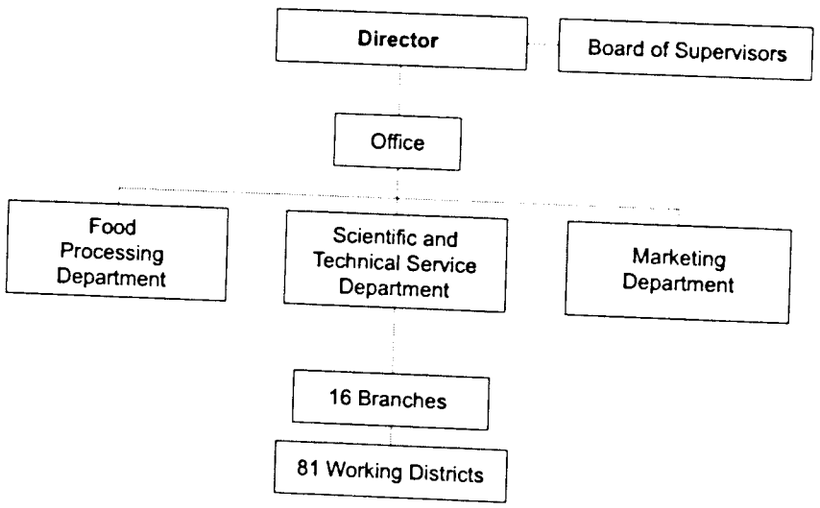


Figure: The Cooperative structure (© Mingshun Song, Yufan Diao, Hongkuan Wu)

3.3 Objectives of the Cooperative

The Cooperative issued a *Constitution of the Shangpan Broccoli Cooperative*, which stipulates the duties, responsibilities, and rights of farmers, processing enterprises, and the sales companies of the Cooperative. The constitution explains the main objectives of the Cooperative as follows. The Cooperative shall draft planting norms for Shangpan broccoli, its planting model graph, and product standards according to the requirements of the CAC standards and Japanese standards (JAS). The Cooperative shall do a good job in technical

training, testing and demonstrating products, and in organizing standardized production and processing. The Cooperative shall lead the industry in planting, processing, trade integration, and opening up domestic and international markets. The Cooperative shall offer standardized seeds, fertilizers, agricultural chemicals and agricultural membrane services. The Cooperative shall set the regulations for production technology; it shall provide all kinds of technological training classes and offer free technological services for members in order to strengthen the level of their operating techniques and management. The Cooperative shall closely observe and predict pest infestation, release timely information about pests, and instruct members in how to prevent and cure pest infestation in order to reduce production costs. The Cooperative shall allocate automatic testing instruments, test quality regularly, and implement quality surveillance. The Cooperative shall implement HACCP throughout processing, apply quality certification, and establish a brand image to make consumers feel assured and break through the Green Barrier.

3.4 Setting standards

By examining the motivation to establish the Shangpan Broccoli Cooperative and issue the Constitution of the Shangpan Broccoli Cooperative, it can be seen that the main task of the Cooperative is to establish standards and operating norms.

3.4.1 Main standards

Helped and guided by the Linhai City Bureau of Quality Supervision and Inspection and the Linhai City Bureau of Agriculture, the Cooperative has outlined broccoli planting standards in 'The Technical Operation Regulations for Broccoli Production', which includes seven parts: the selection of the appropriate variety for a seasonal arrangement of production; the autumn cultivation of shoots, including the seedbed collecting, seedling stages, seedbed management, and meticulous prevention of pests; site selection, soil preparation and field planting; water management in the field, including scientific topdressing and timely watering; plant-pest prevention and treatment for such problems as cabbage caterpillar, beet noctuid, twill noctuid, aphid, etc.; harvesting the crops at the proper time; and garden cleaning and compost. At the same time, 'The Broccoli Quality Safety Management Rule' states that in order to ensure the quality control of broccoli throughout the entire production process, an effective management system should be established and further perfected by fully employing advances in science and technology.

3.4.2 The main contents and requirements of the standards

According to the requirements of domestic and international markets and the aims of the Cooperative, these rules were made for all members to carry out:the basic principles of this Cooperative are quality first; the customer has the utmost priority, alongside honesty. Product quality is the cornerstone of the members' existence. The members' skills are the foundation of quality; and quality is the responsibility of the members. Based on the CAC standards, the regulations of broccoli production technology issued by the Cooperative are to be strictly followed. They also forbid: the use of hyper toxins; high residues of pesticides and the mixing of ingredients; and the polluting of products with pesticides, chemical fertilizers and harmful organisms. To guarantee safe use of pesticides in broccoli production, they must be purchased from the Scientific and Technological Service Department. Department workers must record the amounts and the kinds of pesticides purchased. The department shall strictly supervise safe intervals of pesticide use, and a responsibility-tracing system will be set up.

Members must record the use of pesticides and chemical fertilizers in the book issued by the Cooperative. The sources, names, consumption, service time, and operating methods of the pesticides and chemical fertilizers must be noted. Members supervise each other and should report to the Cooperative immediately upon finding cases of where rules and regulations have been violated. The Cooperative should refuse to purchase products from farmers who do not observe the broccoli-production technology regulations, farmers who do not buy pesticides and fertilizers from the designated department, and farmers who seriously violate other clauses on safe production.

3.5 Promoting the standards by the Cooperative

3.5.1 The implementation mechanism of the standards

Requirements are only stipulated in the 'Management Rules for Broccoli Quality and Safety', though the detailed operation methods are stipulated in the 'Technical Operation Regulations for Broccoli Production'. Because the requirements were complicated and the farmers were inexperienced, the 'Operational Procedure Mode Pictures of Safety in Broccoli Production' was created. In order to enhance the farmers' understanding of this publication, the Cooperative has handed out more than 5,000 brochures and held 20 training classes in which more than 3,000 persons have been trained. In harvest seasons, the training classes are held at each planting base. All the training courses are free. 'The Mode Pictures' is an easy-to-understand model of the standards.

Different kinds of pesticides and the MRL of broccoli (CAC)

No.	Pesticide Name	MRL (mg/kg)
1	ACEPHATE	2
2	AZINPHOS-METHYL	1
3	BROMIDE ION	30
4	CHLOROTHALONIL	5
5	CHLORPYRIFOS	2
6	DIAZINON	0.5
7	ENDOSULFAN	0.5
8	FENVALERATE	2
9	IMIDACLOPRID	0.5
10	IPRODIONE	25
11	MALATHION	5
12	METALAXYL	0.5
13	PERMETHRIN	2
14	PIRIMICARB	1
15	QUINTOZENE	0.05
16	TEBUFENOZIDE	0.5
17	TERBUFOS	0.05

Figure: Different kinds of pesticides and the MRL of broccoli(CAC) (Source: codexalimentatius.net)

The farmers have been willing to implement the standards after being trained. Supervision management is an important link that guarantees efficient production of broccoli according to the standards set. The supervision management method is called '2 sets, 3 records'. The concrete contents of '2 sets, 3 records' are as follows: the first 'set' is a set of proper pesticides, which includes 17 kinds of low-toxicity pesticides; the second 'set' is a set of places for the purchasing of qualified pesticides at reasonable prices. Each farmer has a manual called the 'Registration Card for Buying and Using Agricultural Materials', which includes the contents of the 'Management Rules for Broccoli Quality Safety', the 'Technical Operation Regulations for Broccoli Production', the 'Registration Form for Field Pesticides', the 'Registration Form for Field Fertilizer Use', and 'Member's Information'. The manual is the main source of the '3 records'. The first 'record' includes the kinds of pesticides and fertilizers bought by the farmers. The second 'record' includes the amount of pesticides and fertilizers used by the farmers. The third 'record' includes personal information about the farmers.

3.5.2 The quality supervision mechanism

Quality control includes supervision and inspection. The Cooperative has trained many quality monitors whose duty is to supervise the kinds and amounts of pesticides and fertilizers used by farmers according to the 'Management Rules for Broccoli Quality Safety' and the 'Technical Operation Regulations for Broccoli Production'. Before being purchased, broccoli samples from the farmers must be inspected by the Cooperative. Inspected items mainly cover pesticide residues.

If a member violates the regulations, he/she will be punished according to the rules. For example, the Cooperative must dismiss any member who has used Rogor, not included in 17 kinds of designated pesticides found by the monitor.

3.5.3 The standards as the main clauses and contents of the contract

In the Cooperative, the contract is the main legal document linking the farmers and the enterprises. The farmers and the enterprises realize that the contract is necessary to improve usage of their shared resources. The standards play the key role in the contract.

Some processing enterprises gain advantages from their talent and management, processing equipment, and powerful marketing abilities. But because of the shortage of land, they are short of broccoli products complying with quality standards for processing. This has constituted an obstacle to making good use of their superior resources to achieve economies of scale.

Although farmers own relatively abundant land, most of their products do not conform to quality standards. So their products always have a lower price on the market. Sometimes there are problems of overstocking and sluggish sales because of the lack of technology, management and marketing ability. The leading enterprises and the farmers should complement each other.

Only under the conditions of market economy can bilateral cooperation and sharing of the above-mentioned resources be realized. The Cooperative contract signed by the processing enterprise and the farmers is the legal foundation for bilateral cooperation. The main clauses of the contract are related to standards. These standards are the main contents of and important documents in the purchase contracts.

This is illustrated for the purchase contract signed between Yilong Green Agricultural Product Co. Ltd. (Party A) and the farmer Yuhai Li (Party B). This contract involves 10 articles altogether, of which 4 articles are about standards.

4 Post-standardization situation in the broccoli industry

After adopting standards, the Shangpan broccoli industry began to boom again.

4.1 Economic benefits of agricultural standardization

After establishment of the Cooperative and application of standards in the Shangpan broccoli industry, a number of obvious economic effects have been achieved as follows:

- The farmers have been organized to produce in a modern agricultural mode.
- The quality of most broccoli products is in conformity with the requirements of the CAC and international standards.
- The planting area, covering 55,000 hectares, has been increased by 150%.
- The broccoli products are being exported to the Japanese market again and are welcomed by overseas markets, especially in Singapore, Malaysia, Korea, and Thailand.
- There are 10 types of broccoli products that are exempt from all inspections by Japanese customs.
- The export price has increased by 120%, the cost has been reduced by 50% and economic benefits have increased by 150%.
- The total value reached 1.535 billion CNY in 2004, 71% came from exports.

4.2 Social effects of agricultural standardization

Agricultural standardization has enabled the farmers to use agricultural science and technology widely and correctly. It has also helped farmers to improve product quality, to reduce costs, and furthermore, to reach the goal of increasing agricultural efficiency, thus increasing their income. The farmers have readily accepted advanced agricultural technologies through standardization. These changes have assured that product quality complies with standards, large-scale production is realized, and market shares are enlarged.

Standardization has promoted the farmers' level of scientific technology and management, and helped them use their land efficiently. With good application of agricultural standardization, the farmers' production mode has changed from the individual to the cooperative mode, namely the new agricultural industrialization in China. In the cooperative mode, social labour division is efficient and clear. The enterprises, the farmers and the Cooperative share their work and help one another in coordination and harmonization. The processing enterprises are mainly engaged in marketing, technical development, demonstration, and processing.
The farmers cultivate broccoli according to standards, and the Cooperative implements standardization to coordinate and supervise the production and business affairs of the farmers and the enterprises.

5 Economic analysis

5.1 Introduction

Agricultural standardization has helped processing enterprises and farmers gain benefits from economies of scale. The entire economic benefits for the Shangpan broccoli industry are determined by the success of the enterprises. If the enterprises are in the red and remain this way for a long time, the agricultural economy of the whole region will suffer huge losses and the farmers will see no economic benefits. Because the farmers' economic benefit is derived from the leading enterprises through cooperation, it is necessary to analyse the economic benefits of the leading enterprises. The reasons for the economies of scale of a leading enterprise are analysed by the method of the profit and loss balance.

5.2 The theoretical economic analysis

The theoretical economic analyses can be divided into three steps as follows.

5.2.1 Analysis of the economic situation before cooperation

The total cost of the leading enterprise, including its own land (F) (shown in the following figure), is TC_{S0}. After cooperating with the farmers, the enterprise's land increases $\triangle F$ on the basis of TC_{S0}. F' in the figure is: $F'=TC_{S0}+\triangle F$.
By enlarging land scale, the number of employees, management affairs and production operations will increase. Suppose the increasing wage costs are $\triangle V_L'$,

the increasing management costs are $\triangle V_M'$ and the increasing operative costs are $\triangle V_O'$.

The external trade costs $\triangle V_E'$ and the R&D costs $\triangle V_T'$ increase slightly, the costs are much less than $\triangle V_L'+\triangle V_M'+\triangle V_O'$, that is
$\triangle V_E'+\triangle V_T'<\triangle V_L'+\triangle V_M'+\triangle V_O'$
Thus, $\triangle V_E'+\triangle V_T'$ can be omitted.
TC_{S1}' in the figure is the total cost arising from independent operation after the purchase of $\triangle F$ land by the leading enterprise.
$TC_{S1}'=F+\triangle F+V_L+V_M+V_O+V_T+V_E+\triangle V_L'+\triangle V_M'+\triangle V_O'$

V_L: the costs of labour employed by the leading enterprise
V_M: the internal management costs of the leading enterprise
V_O: the production operation costs of the leading enterprise
V_T: the R&D costs of the leading enterprise
V_E: the external trade costs of the leading enterprise
The total revenue of the enterprise is:
$Y=P_1*Q$.

The balance analysis of profits and losses

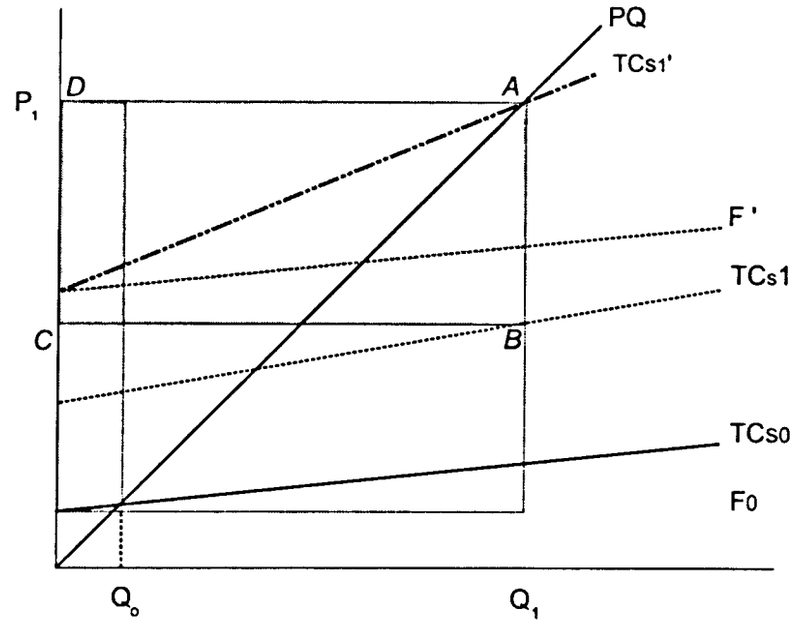


Figure: The balance analysis of profits and losses (Source:© Song)

P_1 is the unit price the enterprise charges for the exported broccoli produced complying with standards. Q is the quantity of broccoli production.
When the enterprise operates independently on the original land (F_0), the equilibrium point of benefit and loss is Q_0, and the maximizing profit is: $Q_0(P_1-TC_{S0}|_{Q=Q0})$

Under the condition of TC_{S1}', that the enterprise operates independently on its land $F_0+\triangle F$, the quantity is Q_1, the price is P_2, and the equilibrium point of benefit and loss is A in the figure. But the total cost of the enterprise has not reached TC_{S1}' in reality since it has not purchased the land $\triangle F$. The enterprise purchases the products cultivated by the farmers who own the land $\triangle F$ instead. The costs are $(Q_1-Q_0)*P_H$. P_H is the unit price at which the enterprise purchases the products from the farmers, and P_H is less than P_2. The cost of purchasing the products is less than the cost of purchasing the land $\triangle F$, i.e., $(Q_1-Q_0)*P_H<\triangle F$.

5.2.2 Analysis of the economic situation after cooperation

After cooperation with the farmers, the enterprise does not need to employ labour to cultivate broccoli on the land $\triangle F$, and the increasing wage costs $\triangle V_L$ can be omitted. Management affairs costs $\triangle V_M$ and the production operation costs $\triangle V_O$ are less than those at which the enterprise cultivates broccoli independently on the land $\triangle F$. That is: $\triangle V_M+\triangle V_O<\triangle V_M'+\triangle V_O'$

The external trade costs $\triangle V_E$ and the R&D costs $\triangle V_T$ increase slightly. The costs are much less than $\triangle V_M+\triangle V_O$, and $\triangle V_E+\triangle V_T$ can also be omitted. Therefore, the total costs paid by the leading enterprise at the price P_1, of which the equilibrium point of benefit and loss is B in the Figure, are $TC_{S1}|_{Q=Q1}$.

That is: $TC_{S1}=F+(Q_1-Q_0)*P_H+V_L+V_M+V_O+V_T+V_E+\triangle V_M+\triangle V_O$
Thus, $TC_{S1}<TC_{S1}'$

Namely, TC_{S1} is the real total cost after the cooperation, and the profits are $Q_1(P_1-TC_{S1}|_{Q=Q1})$, which is the shaded area ABCD in the figure.

Therefore:
$Q_1(P_1-TC_{S1}|_{Q=Q1})>Q_0(P_1-TC_{S0}|_{Q=Q0})$

5.2.3 Analysis of profit sources

The increased profits of the enterprise mainly come from savings in labour costs, operative costs, management costs and land purchasing costs after cooperation.

$$\begin{aligned}\triangle C&=TC_{S1}'-TC_{S1}\\&=(F+\triangle F+V_L+V_M+V_O+V_T+V_E+\triangle V_L'+\triangle V_M'+\triangle V_O')-(F+(Q_2-Q_0)*P_H+V_L+V_M+V_O+V_T\\&\quad+V_E+\triangle V_M+\triangle V_O)\\&=(\triangle F-(Q_1-Q_0)*P_H)+\triangle V_L'+(\triangle V_M'-\triangle V_M)+(\triangle V_O'-\triangle V_O)\end{aligned}$$

$\triangle C$ is the total saving cost of the enterprise after cooperation.

The enterprise only pays $(Q_1-Q_0)*P_H$ to buy broccoli from the farmers who cultivate the broccoli on their land $\triangle F$.

The land price is much higher than the product price, thus:
$\triangle F > (Q_1-Q_0)*P_H$ ($\triangle F-(Q_1-Q_0)*P_H$) is the saving made by purchasing the products instead of purchasing the land $\triangle F$.

$\triangle V_L'$ is the labour cost. If the enterprise buys the land with $\triangle F$, it must pay $\triangle V_L'$ to employ workers to cultivate the broccoli on the land $\triangle F$.

But if the enterprise does not buy the land $\triangle F$, it does not need to employ the workers with $\triangle V_L'$. So, $\triangle V_L'$ is saved.

$\triangle V_M$ is the added management cost because the processing quantities increase from Q_0 to Q_1. If the enterprise buys the land $\triangle F$, the enterprise must manage workers who cultivate the broccoli $\triangle F$.

This management cost is $(\triangle V_M'-\triangle V_M)$. After cooperation, the enterprise does not employ the workers, so $(\triangle V_M'-\triangle V_M)$ is saved. $\triangle V_O$ includes the training cost, project demonstration cost, inspection cost, and the supervision and control cost, all of which are incurred after cooperation.

$\triangle V_O'$ includes the cost of fertilizers, pesticides, irrigation, tools, and vehicles for cultivation. All these must be purchased and maintained by the enterprise if the enterprise operates the land $\triangle F$ by itself. When the farmers operate the land $\triangle F$ after cooperation, the costs of fertilizers, pesticides, irrigation, tools, and vehicles for cultivation are savings for the enterprise $(\triangle V_O'-\triangle V_O)$.

Excluding the market price of broccoli, profit resources come from the savings in labour cost, operations cost, management cost and the land purchasing cost.

These profits are relatively fixed, and the profit $\triangle\pi$ is:
$\triangle\pi=(\triangle F-(Q_1-Q_0)*P_H)+\triangle V_L'+(\triangle V_M'-\triangle V_M)+(\triangle V_O'-\triangle V_O)$

On the other hand, by transferring the advantages of technology, marketing, processing, testing and management to the farmers, the enterprise encourages the farmers to produce high-quality, competitive products and achieve their expected profits.

5.3 Qualitative analysis of the Cooperative

With the help of the local government, the advantages of technology, marketing, and processing in the area have been consolidated and promoted efficiently by the Cooperative. Without increasing the costs of training, marketing, and inspecting, the economic effects on the farmers are commensurate with the advantages of technology, marketing and inspecting, because they obtain these benefits from the companies at no expense.

Without increasing manpower and land cost, the enterprises have sufficient good-quality products from the farmers and achieve economies of scale. New achievements in science and technology, especially advanced planting methods, are described in the standards that have been spread and implemented through understandable means to farmers. The standards are the important technological documents and management regulations. Therefore, standardization is the first objective of the Cooperative.

6 Concluding remarks

The aim of this lecture is to introduce a case study of agricultural standardization. By reviewing this case, the reader will observe a clear example of agricultural standardization in China and understand how agricultural standardization can play an important role in developing the agricultural industry and increasing farmers' income. The reader can also study the theoretical methods that are applied for analysing the effectiveness and efficiencies of agricultural standardization in terms of economic theory. The reader who wishes to deepen his knowledge on agricultural standardization topics may visit the next section ('Bibliography and Resources') as a starting point.

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8 Glossary

Agricultural standardization
Agricultural standardization means the whole process of producing agricultural products according to standards, including seeding, harvesting, processing, packaging and selling.

CAC standard
CAC is the abbreviation of the 'Codex Alimentarius Commission', which was created in 1963 by FAO and WHO to develop food standards, guidelines and related texts such as codes of practice under the Joint FAO/WHO Food Standards Programme. The main purposes of this programme are to protect the health of the consumers and ensure fair trade practices in the food sector, and promote the coordination of all food standards work undertaken by international governmental and non-governmental organizations.

Green Barrier
Green Barrier is one of the international trade barriers set by some countries and is concerned with import restrictions on the grounds of environmental and food safety.

HACCP
'Hazard Analysis and Critical Control Point' (HACCP) Principles and Application Guidelines, adopted 14 August, 1997 by the U.S. Food and Drug Administration, U.S. Department of Agriculture, and the National Advisory Committee on Microbiological Criteria for Foods. HACCP involves seven principles: analyse hazards, identify critical control points, establish preventive measures with critical limits for each control point, establish procedures to monitor the critical control points, establish corrective actions to be taken when monitoring shows that a critical limit has not been met, establish procedures to verify that the system is working properly, and establish effective record keeping to document the HACCP system.

JAS
The JAS (Japan Agricultural Standard) law specifies labelling of agricultural products and other related regulations governed by the Ministry of Agriculture, Forestry and Fisheries of Japan (MAFF).
On 11 June 2000, the revised JAS law was implemented and a new legal organic certification programme was newly launched.

MRL
MRL is the abbreviation of Maximum Residue Limits. MRL is often used in CAC standards. It is the prefix of the maximum residue limits of pesticides, fertilizers, and toxic and hazardous substances on the agricultural product and food.

Shangpan broccoli industry
Shangpan, a town in Linhai City, Zhejiang Province, has advantages in producing and processing broccoli. The Shangpan broccoli industry is a strong competitor in the world market.

9 Key questions

- What is agricultural standardization?
- What does the term 'the Cooperative' mean?
- How does the Cooperative implement agricultural standards effectively?
- What does the term 'HACCP' mean?
- What does the term 'Green Barrier' mean?
- How did the farmers in Shangpan plant broccoli independently before cooperation?
- What is the meaning of 'the farmers joining the economic co-operative organization'?
- What is MRL?
- What are the sources of the economic benefits of the leading enterprise?
- What is the result of agricultural standardization?

Wenke Siedersleben

Abstract

Internationalisation is a process in which business, industry and sciences are becoming increasingly involved in order to benefit from global value chains. International access to expertise, current research results and new scientific methods remain an important basis for work in research and especially in science. Work processes that are designed and organised like projects are gaining significance for international academic cooperation. This paper presents the most important traditional cornerstones of project management. This paper also introduces the variable culture and explains the major effect with regard to successful project management and project implementation. International and intercultural projects in particular will not succeed exclusively through the use of traditional management instruments such as planning, organisation, monitoring and controlling only; intercultural and international divergences have to be taken into account. However, the factor of culture is too seldom addressed, or addressed only marginally in traditional management literature. Since this issue has not yet been sufficiently explored in the discussion of successful project management, it will be the focus of this paper.

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There are two things in which all well-being consists:
one is the choice of the right target and aim of action,
the other, to discover the path leading towards its achievement.
Aristotle

1 International Project Management in Research and Science - an Introduction

Internationalisation is a process in which business, industry, research and science are becoming increasingly involved so that they can benefit from global value chains. International access to expertise, current research results and new scientific methods remain an important basis for daily work in research and science. International cooperation and international research networks shape new findings and knowledge processes and accelerate the transfer of knowledge. Work processes that are designed and organised like projects are gaining significance for international academic cooperation. These processes involve deviation from existing structures of authority and responsibility. Project work means attaining project goals with new teams and new workflows, limited resources and clearly defined time schedules. Innovation and change in particular are not brought about through standardised methods of working and unvarying processes, but rather through the connection of new concepts and new ways of working. Specifically, internationally oriented projects make it possible to respond proactively to complex, accelerated conditions in the research and scientific work undertaken in today's world. International projects involve carrying out innovative work in a matrix or network, away from formal hierarchies, under time pressure, in globally distributed teams with a heterogeneous team structure and culture. Project-based work has the potential to become the future way of working in research and science.

2 Background

This paper presents the most important traditional cornerstones of project management. These cornerstones are examined and discussed in the context of the EU-Asia Link Project organised by the Professor for Technical Drawing and Standardisation, Prof. Dr.-Ing. W. Hesser, Helmut Schmidt University Hamburg/ Germany. The paper also introduces the variables of internationality and culture and explains the effects with regard to successful project management.

The most common project management methods do result in successful project work, but they are not sufficient tools on their own. International and intercultural projects in particular will not succeed exclusively through the use of traditional management instruments such as planning, organisation monitoring and control; intercultural and international divergences need at least awareness and consideraton. However, the factors of internationality and culture are seldom addressed, or are addressed only marginally in traditional management literature. Because these issues are not sufficiently explored in discussions about successful project management, they will be the focus of this paper. Successful international and intercultural cooperation is determined by team-building processes, the choice of partners, risk management, and project leadership which is communicative and - above all - unprejudiced entailing mutual respect despite cultural differences. This is the only way that the factors of internationality and culture can generate the desired benefits and actual added-value, since otherwise they can act as barriers to successful cooperation and efficiency and may cause projects to fail. This effect is stronger and more pronounced the larger the distance between participants, the greater the differences between continents and the more heterogeneous the mentalities and cultures involved.

3 Project Management - General Features

What is the definition of management? What types of management are there? The term 'management' is used frequently but is rarely defined in a sophisticated manner. Management is generally associated with terms such as guidance, leadership and planning. A distinction is often made between institutional and functional management. In the former case, individuals or groups with definable roles perform defined activities and tasks by hierarchy. From a functional perspective, management means assigning processes and positions to functions such as planning, leadership and monitoring (Carsten, P., 2002).

When do we talk about a project? Projects are non-recurring, short-term endeavours with a highly complex and interdisciplinary character. Despite meagre resources, projects often have ambitious goals (Gassmann, O., 2005). Although there is currently no single definition of the term 'project' in the literature, for the purposes of this paper, projects are considered to have the following characteristics: a) the project work is divided into tasks, b) there is a deadline, c) the endeavour is non-recurrent, d) the budget is task-related and e) the endeavour is unique. In a project, sequential and parallel processes are intensively interlinked. In the beginning of a project, some of the measures required for this may remain undefined and be surrounded by a great deal of

uncertainty. This makes it difficult to achieve the project goal, in time and in budget.
Project work must be distinguished from routine tasks with a set result and standardised work processes, as well as from programmes in which individual projects are combined (Carsten, P., 2002). Project workflows grow in a process-like, organic, systemic way and can only be planned to a certain degree.
More often than the standardised work of daily-routine, workflows must be developed and defined on an ad hoc, situational basis. Project management comprises planning, controlling, leadership, monitoring and coordination of short-term endeavours and requires project-oriented leadership. Project-oriented leadership often precludes the sole use of traditional management methods. This entails a renunciation of hierarchies, a flexible project organisation with a results-based orientation, and the development of a project culture (Carsten, P., 2002).

Project-Defining Factors - General Features
According to Gassmann, O. (2005, p. 8), successful project management always consists of the following components:

1. Project goal
2. Organisation, decisions, planning, control and monitoring
3. Leadership
4. Creativity and self-management

An onion is often used as an analogy for this. The components are figuratively arranged as follows: The project goal is at the core of the matter. The second layer consists of a) organisation, planning, control and b) monitoring, and c) decisions evenly distributed. The third layer is composed entirely of leadership, while the outer layer is made up in equal parts of creativity and self-management. The hard variables are found in the middle - the core element is always the project goal, followed by planning, control, monitoring etc. - while the soft factors are in the outer layers. Based on working experiences this model needs to be specified and special attention drawn to the following project-defining factors.

Traditional project management

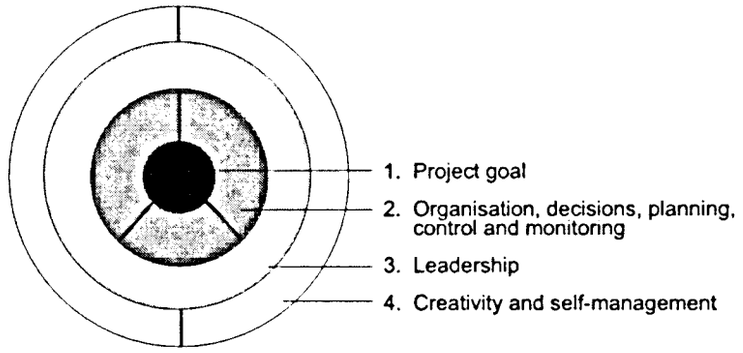


Figure: Traditional Project Management

3.1 Project-Defining Factors I: Project Goals, Phases and Risk Management

This section presents the most important traditional cornerstones of project management. It describes the onion analogy. According to the factors determining the success of a project, success is always based on clearly formulated project goals as well as planning, control and coordination. The model described will be expanded in more depth through factors I to IV. Particular attention should be paid to sections III and IV, namely to the position of the project coordinator and to the factors of communication, creativity and motivation. Project goals are usually developed on the basis of the SMART method (Meiffert, M., 2005, in: Gassmann, O., p.138), according to which a goal should be:

- S = specific; that is, a concrete formulation of the final state
- M = measurable; that is, it is possible to gauge and visualise the goal and its attainment
- A = action-oriented; that is, participants can influence changes
- R = realistic; that is, ambitious but still achievable
- T = time-framed; that is, achievable within a reasonable time

The project goal is always the basis of successful project management. An important goal for a succesful project is that is should be relevant (it meets the requirements), achievable, accepted (the team and the individuals affected are behind the goal), motivating (the goal is challenging) and operative (the goal is clear and comprehensible) (Gassmann, O., 2005, p.10).

Project Phases and Risk Management

Projects frequently move in the so-called 'magic triangle' of budget, scope and time. There are strong dependencies between the individual variables in this magic triangle. Any change to one variable will cause the others to shift. This magic triangle model is fluid and has a varying effect in each phase of a project. If a decision is made in favour of one or two of the variables, the remaining variable must be tolerant. All of the variables together determine the success or failure of a project (Gassmann, O., 2005, p.10).

If a project is in danger of failing and these three variables are not fulfilled, the following phases can be identified:

1. Enthusiasm
2. Disillusionment
3. Panic
4. Search for the guilty party
5. Punishment of innocent parties
6. Commendation and reward for non-participants
7. Destruction of all useful documents (Gassmann, O., 2005, p.15).

What does 'risk' mean in the context of a project? Risk is a product of failure and loss and can be brought about through certain activities. Risk expresses itself as the discrepancy between expectations and reality, and, as such, it has a strong influence on the successful course of a project life cycle. It is particularly important to develop an effective risk management strategy during the planning phase. A risk management strategy should cover the magic triangle of time, costs and scope, as well as all sub-areas. Platz, J. (2005) says that risks arise from:

- carelessness,
- misunderstandings due to inadequately clarified communicated information,
- incapability of partners due to insufficient capacity and expertise,
- uncertainty due to a lack of verified information available to everyone,
- external, unpredictable influences and
- random events.

In these cases, risk management involves endowing work packages with built-in buffer time, developing critical paths and viewing the work as an iterative process. Risk scenarios are divided into three categories. Class A risks have far-reaching consequences and a high degree of probability. Countermeasures must be developed during the project planning phase to respond to such risks. This also applies to class B risks of moderate concern and probability, which are handled on a situational basis. No list of measures can be drawn up for class C scenarios, which have a low level of probability and significance.

Class A, Class B, Class C risks

Class A:	far-reaching consequences and a high degree of probability, countermeasures developed during the project planning
Class B:	moderate concern and probability, handled on a situational basis
Class C:	low probability, no countermeasures

Figure: Class A, Class B , Class C riks

3.2 Project-Defining Factors II: Project Organisation

Projects can be organised along several levels according to regions, hierarchies, processes or informal networks. This may entail staff organisation, matrix organisation or pure project-oriented organisation. New variants of supporting organisations, cross-company projects, virtual projects and project leader pools can be found.
According to Gassmann (2005), the traditional staff and project-oriented organisation scenarios are configured as follows: Structures and positions are maintained with an organisation and are supplemented by a project coordinator who acts without the authority to issue orders and without direct responsibility for unsuccessful projects. This offers flexibility and prevents the need to reorganise or transform an organisation, but these advantages can be counteracted through the lack of 'ownership', which may cause the project to lose momentum leading towards a high level of frustration among employees. This can only be avoided if the project has a sponsor of high seniority with great interest in the project results.
In the pure project organisation scenario, team members are drawn from their permanent departments and consolidated as a unit under the leadership of a project coordinator. The project coordinator has considerable authority in terms of scope, scheduling and costs. This type of organisation has disadvantages for the employees, who are deployed solely to achieve the project goals and must then return to the line organisation without having gained any further qualifications.
A matrix organisational structure helps neutralise the disadvantages of the two forms of organisation described thus far. Employees remain in their departments, and access rights to employees are granted only for issues related to the project. Even though this form of organisation is widely used, conflict is

inherent since it takes a great deal of effort to define boundaries, and competencies and capacities are divided or lost.
The newest forms of project organisation are pool, multi-project and virtual organisational structures. In a pool, individual departments act as service providers and sell their services to current projects; the entire line organisation is reconfigured in this case. Multi-project management takes place when several projects, which may be located in the same project office and may compete for the same resources, are being carried out in parallel. In this case, the project office controls all of the individual projects. It is currently morecommon for the core of a project to be geographically distributed. Gassmann, O. (2005, p.42) asserts that these projects, which have a virtual character, can, in reality, often represent virtual disorganisation.

3.3 Project-Defining Factors III: Project Coordinator or Manager or *both*?

The success of international project management depends heavily on the project leader - often known as the coordinator or manager - who must have the *'diplomatic sensitivity of an ambassador'* (Gassmann, O., 2005, p.17). Project managers face the difficult task of attaining ambitious goals in complex environments where they do not have full authority to issue orders and where there is a limited amount of time to draw on resources. The way in which a project coordinator acts is based on his or her education, personality, conviction and experience and has a decisive effect on the type of project management employed. The focus of the project management strategy will differ depending on whether the project coordinator places value on key figures, system configuration, the system performance of the end product, quality control or documentation.

A typology of seven project leadership types is helpful here
(Gassmann, O., 2005, 6-8):

1. The **project manager/coordinator is a visionary** with the power of persuasion and charisma, who does not have detailed knowledge, but who develops products with double the performance at half the cost in half the time.
2. The project manager/coordinator is a **goal-oriented strategist,** who develops concepts, work packages, sub-goals and alternatives and for whom the achievement of the goal is the highest performance criterion.
3. The project manager/coordinator is an **organiser and administrator,** who is responsible for answering the question of who must do what by what point in time.
4. The project manager/coordinator is a **process and workflow designer,** who exerts control across departments and functions and attempts to surmount individual interests through integration and coordination.

5. The project manager/coordinator is a **moderator and integrator** with a strong team-oriented, participatory approach (a team being characterised by internal cohesion and a shared goal) who commits individual personalities/ personalities of the same type to the project, since imaginativeness can lead to impatience and egoism in individuals, with the result that they do not achieve much in complex organisations and institutions.
6. The project manager/coordinator is an **information disseminator** and knowledge worker, who views the project through key figures, working groups, micro-management and controlling, but who is frequently detached from the actual project activity.
7. The project manager/coordinator is a **methodologist and tool expert,** who views the project as a toolbox and whose way of working involves comprehensive planning, monitoring and control and a belief in the omnipotence of a method which, when implemented, will lead to success.

3.4 Project-Defining Factors IV: Communication, Creativity, Motivation

According to Gassmann (2005), a distinction can be made between context-rich and context-poor *communication*. Context-rich communication is situational and involves a great deal of body language. Context-poor communication, on the other hand, is verbal and focuses on the written word. When context-rich communication using body language and situational clues collides with context-poor communication, misunderstandings are inevitable. Direct, verbal communication fixated on the written word - such as disciplinary efforts which make reference to concluded contracts - often meet with incomprehension. Formal communication, and particularly informal communication beyond official meetings and workshops, represents the most important moments in international projects. For example, the question of resource allocation should be clearly formulated and communicated during the planning phase. This should take place formally and vertically along the hierarchy, but also informally and horizontally along the structure in the working groups. Communication difficulties may have a number of causes. They may arise through the negation of cultural differences, distorted perception, misinterpretation or incorrect assessment. Negations come from the lack of a shared foundation on which to exchange information. It is assumed that the other cultural group engages in similar communicative behaviour. In this case, project employees may lack sensitivity and empathy. When perception is distorted, each project member will select, organise and assess information in their respective cultural environment differently through external stimuli. Reality is perceived in a very subjective way. Misinterpretation occurs when assumptions are interpreted as facts due to culturally different perceptions.

Prejudices and stereotypes are encountered frequently in international cooperation. They arise from inadequate knowledge of the cultures involved in the project. The incorrect assessments that they cause clearly show up cultural divergences. Things are evaluated as good or bad, right or wrong, according to one's own cultural background. The other project members are measured only against one's own value standards and are thus judged in an inaccurate or incorrect way (Bormann, J.G., 1996).
The factor of *creativity* is frequently found in research and development projects, where a high degree of innovation is important. Creativity can be viewed as the ability to solve problems, and it often demands a high number of heterogeneous styles of thought. When combined, the linear/analytic (rational) and intuitive/holistic (emotional) ways of thought idealistically lead to a high level of creativity. Both styles of thought should be represented in the group, but the moderator must exert a strong influence. The point is not simply to present the sum of what is already known. It is more about new patterns and combinations of practical knowledge and new knowledge, and academic, artistic or process-like activities. The degree of creativity is determined largely by the group itself. The more diverse the group - with representatives from different subject areas, for example - the greater the problem-solving capability, the knowledge and the ability to develop strategies. However, it may be difficult to cooperate with highly creative group members since they often disregard constraints, conventions, rules of conduct and scheduled, structured project workflows. Projects should only draw on creative individuals on a selective basis to solve particular problems (Geschka, H., in Gassmann, O., 2005, p.157).
Motivation is, first and foremost, a person's willingness to achieve a certain goal. The effort expended and the individual's behaviour are oriented exclusively towards this goal. The incentives to achieve the goal may come either from psychological motives resulting from the need to compensate for a deficiency, or from values, emotions and convictions. In these cases, it is important for project managers to differentiate between intrinsically (internally, from the activity itself) motivated employees and extrinsically (satisfaction through external circumstances and systems of reward) motivated employees. This assessment is based on two different theories related to certain views of humanity, even though critically examined they are rather simplyfying. On the one hand, the assumption is that people have a natural aversion to work and attempt to avoid it, so they must be guided and controlled. According to this point of view, individuals have little ambition and desire security above all. On the other hand, a concept of humanity views work as a calling and source of satisfaction; a high degree of identification with the work makes external controls unnecessary, since self-realisation is an important incentive to work (Carsten, P., 2002).

4 The 'Standardisation Asia Link' Project Management

The EU-Asia Link programme of the European Union took on the task of strengthening European-Asian university cooperation and promoting projects with innovative profiles. During the first application round in 2002 and 2003, over 240 applications were submitted to the International Relations department of the European Commission in Brussels. Only 154 of these (64%) were accepted, and only 42 applications (17.5%) were selected. One of those selected was the e-learning project called 'Standardisation in Companies and Markets' from Wilfried Hesser, Professor for Standardisation at Helmut Schmidt University Hamburg, Germany. In this project, an English-language curriculum for standardisation in companies and markets is being developed on a modular basis and created in international teams from China to Indonesia. In 2007 the e-learning curriculum was available on the Internet and in the form of an 700-page textbook. The Asian partner universities will offer the entire curriculum as part of a master's degree course for engineering and business students. The curriculum consists of 22 teaching and learning modules which cover current issues in standardisation and include several case studies. Supplementary multiple-choice tests, frequently asked questions, exercises and glossaries are being developed and formulated for each teaching and learning unit, which will endow these tutorials with pedagogical added-value. The technological basis for this lecture series is the open-source e-learning platform of Helmut Schmidt University Hamburg, Germany.

Project Component I: Development of the English-Language Curriculum on Standardisation

Each of the country teams, the academics from Rotterdam, the Netherlands and Hamburg, Germany, and the academics in the four teams from China, Indonesia, Vietnam and Sri Lanka will deliver a 30-page academic text in English combined with tests, illustrations, FAQs, exercises and a literature list. At the end of the project, the 22 teaching and learning modules submitted to Hamburg will form the entire English-language curriculum for 'Standardisation in Companies and Markets'. The learning modules on standardisation will be discussed together with an external academic review panel, and only then will they be released for e-learning implementation and book publication. The Asian teams will also be able to use the e-learning curriculum and textbook to generate teaching and learning units for academic publications (Siedersleben, W., 2005).

Project Component II: E-Learning

There is no clear definition of e-learning. Like the term 'telematic', which combines telecommunication and informatics, 'e-learning' represents an intersection of elements. E-learning is also referred to as multimedia learning, learning with new media, or virtual and online teaching and learning.

What all of these terms have in common is the use of new information and communication technologies. E-learning can entail a higher degree of Internet-based learning at a higher standard of quality than in traditional educational settings. This project views e-learning as computer-based and web-based teaching and learning supported by open-source teaching and learning management software. The methodological concept behind this is a blended learning approach which combines phases of media or online learning with face-to-face teaching. One can note that terms such as 'new media', 'multimedia learning environments' and 'e-learning', however, serve the language of marketing and are ambiguous buzzwords. The terms cannot be considered to have a academic basis (Niegemann, H.M., 2001).

The use of teaching and learning management software based on computers and the Internet should support current teaching methods at universities. In future, it should also enable education institutions to organise entrance examinations, course management and diverse educational programmes. The result will be the generation of knowledge anytime, anywhere, for anyone. The advantages offered by electronically based educational programmes, if these processes are accompanied and configured, are clarified by Zimmer, G. (2004) on the basis of the following four categories. With the help of IT and the Internet, the contiguous process of teaching and learning is decoupled and thus made independent of time and place. This spatial and temporal independence creates space for learners and teachers and removes the boundaries of direct determination for participants. However, the teaching and learning arrangements must be associated with learning goals. Otherwise, there is a danger that the teaching and learning process will fragment and disintegrate. The second aspect of multimedia teaching and learning relates to access to open and diverse educational resources. Materials and expertise can be accessed more quickly and easily with IT and the Internet. The publication of results on the Internet, study materials with specific learning goals, and the direct participation of the learners themselves are additional knowledge resources. The third positive effect is differentiation and diversity enabling individualised teaching and learning arrangements by developing areas of concentration and offering a variety of learning paths and rhythms, as well as modularised learning materials. Learners and tutors are interactively linked through technical discussions and cooperation in virtual spaces so that they can create shared, group-oriented knowledge and learning programmes. The fourth dimension of virtual educational programmes is that learning and work are converted into new forms of communication and cooperation. In an international context, in particular, new social contexts,interest and learning groups are formed.

German universities still face the challenge of overcoming the '5% hurdle' of new media usage in teaching. At Helmut Schmidt University, the University of the Federal Armed Forces, this challenge has already been met. Thanks to the E.L.I.P. team in Hamburg led by Prof. Dr-Ing. W. Hesser, e-learning has already passed the 5% limit and is being used by around 20% of the professorships. With the help of an e-learning coordination office, and building on the use of open-

source software, all of the opportunities offered by an IT-based teaching and learning management system are being explored. In addition to the professorships, this platform is also being used by the computer centre and the library. Furthermore, through nationwide cooperation with other institutions, such as Munich University of Technology and RWTH Aachen University/Germany, a variety of other users are also involved (Koch, K.; Hartung, M.; Hesser, W., 2005). The Asian partner universities in this project will draw on the existing e-learning structure of Helmut Schmidt University Hamburg. A user group will be able to log in with passwords via the Internet to gain access to the 22 modules created in the course of the project, along with their FAQs, multiple-choice tests, exercises and glossaries.

4.1 Project-Defining Factors I: Project Goals + Phases = EU-Asia Link Risk Management

Remembering the figure, one can describe this Asia Link project in the following manner. In the EU-Asia Link standardisation project goal, each team member was expected to produce two academic articles on current standardisation issues within a period of 2½ years. The development of the overall profile and the final decision on the 22 individual topics was completed by consensus by the project group during workshops in the first half of the first project year in 2004. These 22 articles are available both in a published book and as an e-learning lecture series on the Internet. The amount of work was planned to some extent to be realistic and achievable for each team member, since academic writing is one of the qualifications required of a university faculty member. The project idea was supposed to create a 'win-win' situation for all academics, since all team members a) would be provided with innovative pedagogical and infrastructural added-value to their respective universities through their e-learning contributions, b) would have two of their own articles published in the textbook and c) would improve their own reputation through their participation in an international EU project. The content once generated was intended for the online world on the one hand as well as for print media, but the idea and concept was compiled with insufficient consultation on feasibility with multi-media experts.
This Asia Link project was mainly risk management: when referring to so called 'Class A' risks (high probabilities and strategies to develop in advance), here the absence of operational, process-oriented risk management strategies during the planning phase were a major challenge; the projct office ranked as the Class A risk (high probality, major influence) 'quality and ability to produce high-end content' as the major challenge. It was tackled via coaching, mentoring, establishing a virtual library and giving out guidelines on how to develop the needed content.

'Class B' risks (occuring *ad hoc)* are *if* not all team members meet quality standards; one of the overall six teams was extended internally in accordance with the relevant tasks in order to fully meet quality standards. The Class B risk (moderate concern and probability) was based on the apprehension when it comes to the variable budget and time, which was tackled ad hoc but had having a buffer, took a critical approach to extending time schedules and workloads while still allowing for a 'moderate finish' in the worst case. 'Class C' risks, such as the Tsunami 2005/6 in the participating countries Sri Lanka and Indonesia, unforeseen (low probability and usually no emergency scenario developed). The Class C risk (unforeseen and no counteractive measures planned) hit this project hard in 2005 and 2006, when the Tsunami 05 partly destroyed our partner university in Sri Lanka and our partner country Indonesia.

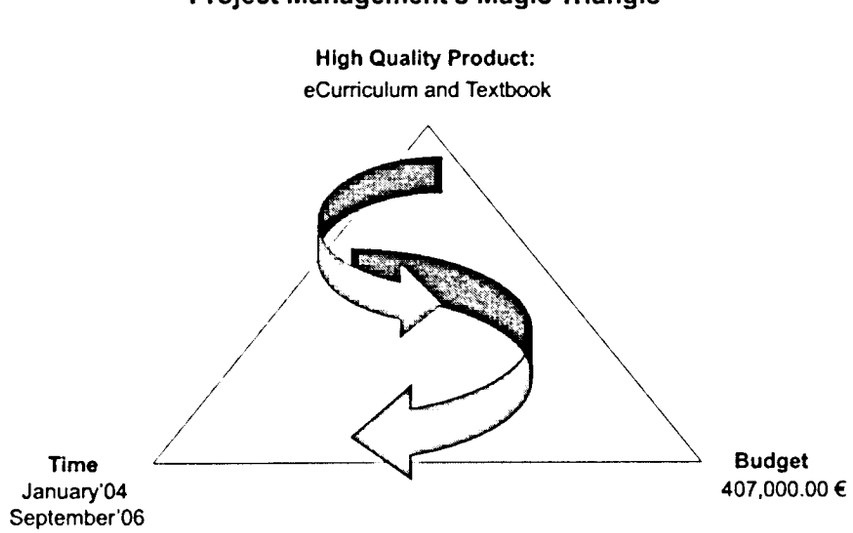


Figure: Project Management's Magic Triangle

4.2 Project-Defining Factors II: The Project Organisation in the EU-Asia Link Project

The virtual organisational structure found in the EU-Asia Link project is being encountered more and more frequently due to increased internationalisation. In this type of organisational structure, several geographically distant teams are virtually connected and unified by the project goals. The team in the project office in Hamburg centralised all issues of planning, control, coordination and budget. The organisation chart is rather centralised in a sense that actions and administration and the actual project implementation were conducted by the team in Hamburg, in coordination with the European Union, which set a complex set of rules on budget, administration and overall implementation for the beneficiaries. The team in Hamburg further cooperated wth their local university administration, the e-learning team and the co-management in Rotterdam. The team members in Asia were able to concentrate on developing the content.

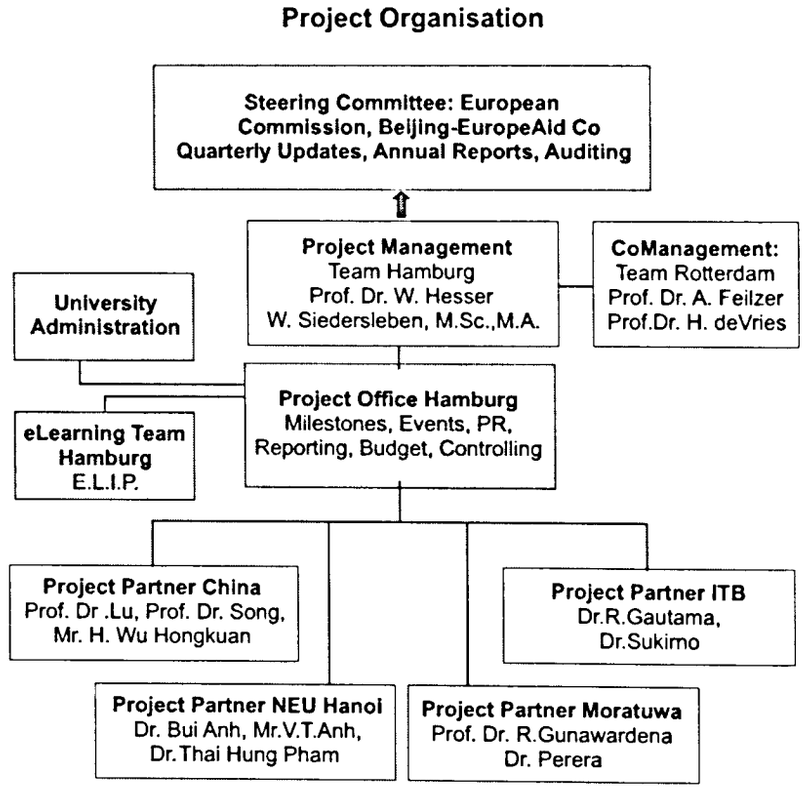


Figure: Project Organisation

4.3 Project-Defining Factors III: The Project Coordinator as Primus inter Pares

As described earlier the 'seven project leaderships types' are: **manager/ coordinator, who is a visionary; goal-oriented strategist; organiser and administrator; process and workflow designer; moderator and integrator; information disseminator** and knowledge worker; **methodologist or tool expert.** In this European-Asian science and research project, the application of one of these typologies does not guarantee project success. Instead, the different phases and intensities of a project require different types of project manager and different character facets, as already discussed in Chapter 3. Working together with Asian partners from an extremely context-rich environment (symbols, rituals, personality, position, status, reputation) demands multi-typological project leadership. This involves finding the intersection between strategy, integration, administration and process configuration. The project leader strengthens his or her position more as a goal-oriented strategist, administrator, process designer and integrator than through tool expertise, strength of vision, knowledge work or controlling.
Above all, international - and in this case, European-Asian - project management requires a high degree of mental mobility, flexibility, social competence, emotional intelligence and intuition. A project coordinator must be permanently active in order to avoid losing team members. This is the most significant task for the project coordinator when navigating six universities working together in Europe and in Asia.

4.4 Project-Defining Factors IV: Communication

Communication is the starting point for successful project cooperation, even when this presents great challenges to an international, geographically distributed group. Ethnocentric arrogance can be a breeding ground for intercultural communication problems. In European-Asian projects, there are certain standards of communication, meaning, that compared to traditional projects, the daily focus of activity in virtual projects is team-building and communication. The large amount of communication needed here, which is associated with team-building processes, is often underestimated and can lead to the failure of a project. In this case, the Internet and modern information and communication technologies are not just important; they are actually prerequisites for the feasibility of such a virtual project. One needs to check the feasibilty of the project by exploring the surroundings and local settings. External international service providers may supplement the permanently accelerated exchange of data, but telephone calls and regular, ongoing Internet-based communication are absolutely vital in the daily work accompanying the project activities. The project work is supported by asynchronous communication through e-mail and

forums, along with synchronous communication in the form of chats. The learning management system helped with the filing of data and the establishment of a virtual database providing all project participants with access to academic articles. In the project planning and conception phase, the limited number of personal meetings was reduced to 3 workshops in 33 months due to the tight budget allocation during the planning phase. All team members came either from engineering or business faculties, while one project coordinator had a background in the humanities. Tasks were distributed on the basis of formal qualifications: the subject-area experts in individual teams were responsible for content, and the generalists were responsible for project implementation. Due to the virtual character of the project, greater value had to be placed on activities which promoted communication and the exchange of information, as well as on team-building processes. Advice was received that a pre-project meeting with potential partners would be advisable before a partnership agreement could be signed.
Due to the very high proportion of academics in the project, the decision reguarding a motivation-oriented leadership style was made at the start of the project in favour of less control and more coaching and support on a coaching level.

5 The Variable of Culture - Can Europe Meet Asia and *vice versa*, or is it Squaring the Circle?

As already explained earlier in Chapter 3, and although these common project management methods ideally result in successful project work, they are not sufficient on their own. Returning to the figure mentioned earlier, the following chapter argues that the general management model should be extended by the variable 'culture'. The variables of internationality and culture together with their effects are also important for successful project management. For this reason, these variables are the focus of the following chapter.
The term 'culture' comes from the Latin *cultura*, meaning *colere*, to tend, in the sense of 'tending body and soul.' It was in 18th-century France that the term culture was first associated with an educated, cultivated individual (Carstens, P., 2002). In a positive sense, culture refines humans and their (technical) abilities and skills. Human culture uses symbols, speech and writing in association with values and general rules of conduct, gives meaning to life. A culture manifests itself in cultural artefacts, architecture and works of art (Feldmann, K., 2005). However, culture *per se* cannot be explained by a single concept or definition. The definition and characterisation of culture depends on the respective standpoint and academic discipline. In this section, the sociological perspective is the focus of attention.

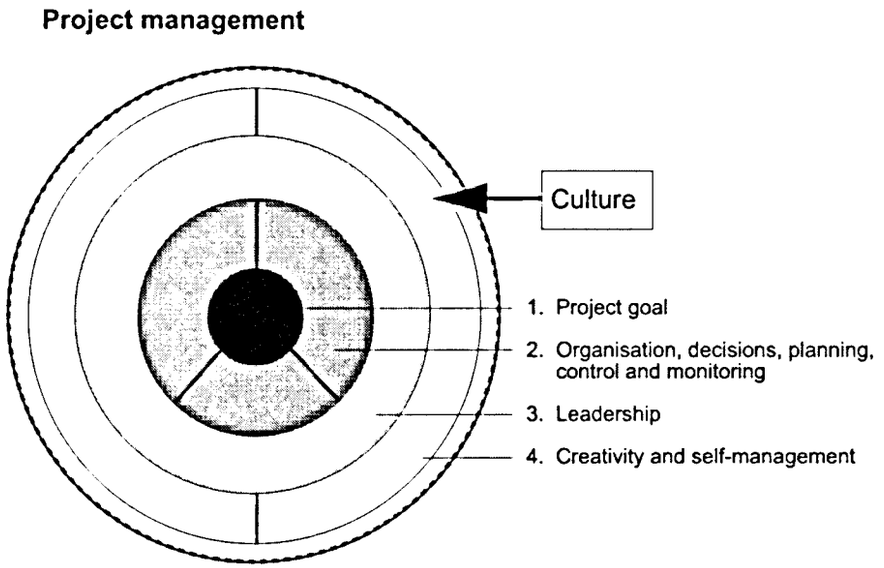


Figure: Project Management

Viewed sociologically, culture is a spatially and temporally delimited aggregate of the shared material and products by a community. Culture is borne by the internalisation of values and interpretations of meaning. It is the institutionalised form of living by an individual person or in a community and its knowledge, beliefs, art and morals. The term culture relates to parts of an area (regional culture), to domains (sub-cultures) and to other similar societies in a cultural group (Schäfers, B., 2001). Culture entails the entire social heritage, consisting of the knowledge, beliefs, morals and customs that a member of a community adopts, as well as non-material social achievements such as art and religion (Reinhold, G., 2000).
Since the modern period, the term culture has been a synonym for a person's affiliation with a group. Culture can be either an exclusionary criterion or a characteristic of belonging to a particular social class or group. Culture is a defining distinctive feature which is reflected in the communication typical of a group or class, in speech, in appearance and in social relationships and convictions (Harris, P.R.; Moran, R.T., 1993). Culture is mental software. According to Hofstede (1997), culture can be divided into 'Culture One', which entails the refinement of the intellect through education, art and literature; and 'Culture Two', namely, the customary trappings of life such as greetings, eating, revealing or hiding emotions, and the maintenance of physical distance.

Culture is: *'always a collective phenomenon [...].It is the collective programming of the mind which distinguishes the members of a group from one another.'*(Hofstede, G., 1997, 363)
Culture 1) shapes behaviour and is endowed with values, 2) is learned and inherited, 3) is a collective, social phenomenon, 4) manifests itself in visible artefacts and 5) provides a sense of orientation, identity and purpose to individuals and groups (Stüdlein, Y., 1997).

5.1 Culture in an Institutionalised Form: Cultural Concepts, National Culture and Religion

Culture from an institutionalised point of view, as manifested in the culture and/or religion of a country, can be the most underrated variable in European-Asian projects. Culture can be found particularly in national cultures, religious differences and in differing cultural concepts, which will be presented here and then explored on the basis of the 5 Cultural Dimensions Model by Hofstede.

5.1.1 Hofstede's 5 Cultural Dimensions Model

Different cultural concepts can be found in work-related processes. These cultural concepts, in connection with a country's culture or religion, have been empirically validated and developed - if in a very compressed and simplified way - by Hofstede (2005; 1997; 1993 a,b) as follows. Hofstede gathered data on the world's cultures and by that generated raw dimensions scores for 56 countries and regions. Respondents answered 20 content and 6 demographic questions on culture-determined differences based on survey model samples. Hofstede has continued to develop his 5-dimension model since the 1960s. This schema illustrates cultural differences but, viewed critically it is only a rough system of coordinates which offers points of reference. The system of classification merely allows the variable of culture to be illustrated and viewed more transparently, and it describes very simplified possible behavioural differences. When examined critically, this schema is not exhaustive but tends to be more explorative. However, cultural blind spots between geographically distant countries must not necessarily always be barriers to cooperation. Even culturally similar partners may go through difficult phases in a project. This schema should instead be seen as a 'leitmotiv' in inter cultural cooperation projects, with occasional disruptions due to individual personality and each person's international and intercultural experience. Reducing all partners to this 5-D pattern would entail ignoring the factors of social background, individual character, ethnic background and educational level and would not do justice to a partnership on equal terms. The following five dimensions by Hofstede help identify and classify cultural differences.

The 5 dimensions are:
- Power distance
- Uncertainty avoidance
- Collectivism vs individualism
- Masculinity vs femininity
- Long-term vs short-term orientation

Power distance index: 6 countries in comparison (Based on Hofstede)

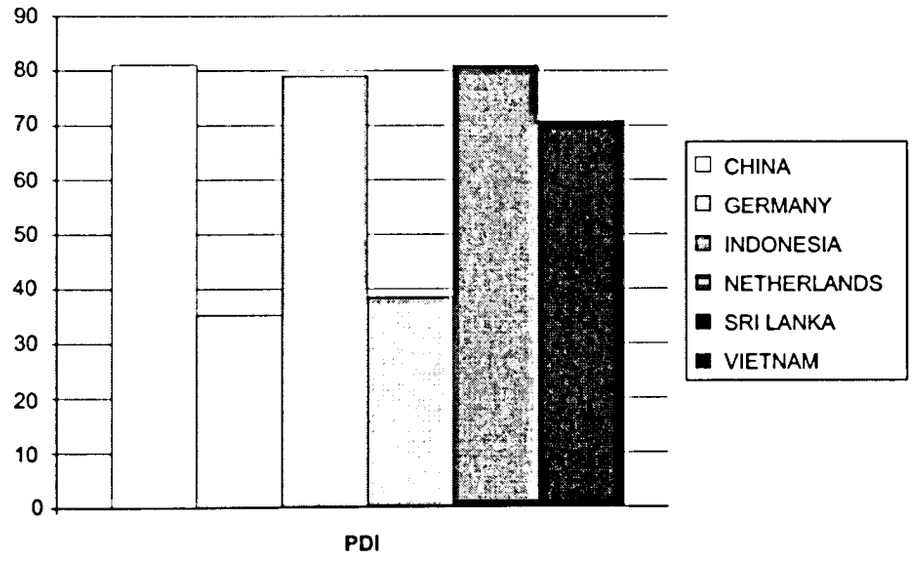


Figure: Power distance index: 6 countries in comparison (based on Hofstede), at www.geert-hofstede.com, in alphabetical order by country.

Cultures may have a higher or lower power distance rating (Hofstede, 1994).
In a culture with a high power distance rating, power and the powerful per se are legitimised, enjoy privileges and occupy hierarchies as a reflection of natural social superordination and subordination.
Hierarchies are accepted and respected. The manager is a benevolent autocrat with a tendency towards centralisation, and employees expect instructions and regulations. In scenarios with a low power distance rating, on the other hand, all individuals have the same rights, and predominant ideologies determine the balance of power. In day-to-day activities with a low power distance rating, employees expect to be included in decisions, and the ideal manager is a democrat with a tendency towards decentralisation. Hierarchical differences

play a subordinate role. Comparing two regions such as Europe and Asia, one can see that there is a big similarity between the Asian countries having a high power distance index. The European partner countries apparently have a low power distance index.

Uncertainty avoidance index: 6 countries in comparison

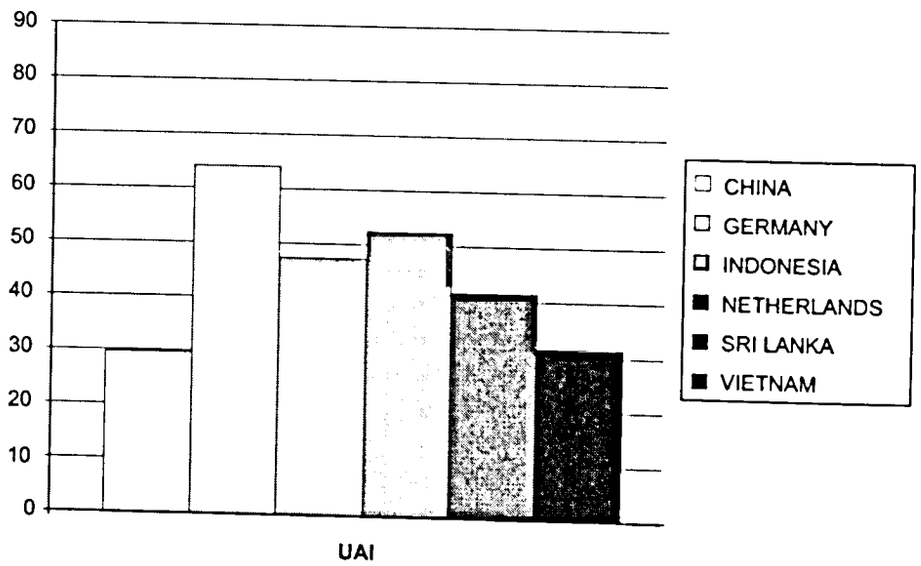


Figure: Uncertainty avoidance index: 6 countries in comparison (based on Hofstede), at www.geert-hofstede.com, in alphabetical order by country.

The dimension of uncertainty avoidance differentiates countries/professional groups/organisations/cultures according to a higher or lower tolerance of uncertainty. In cultures with a low uncertainty avoidance ranking, risks are taken and tolerance is shown towards others, although not with aggression or emotion. Time is an orientating factor, and the laws and rules of the culture are few and generalised. There is commonly an aversion to regulations, achievement is generally the source of motivation, and there is little formalisation or standardisation. The characteristics of countries/professional groups/organisations/cultures with a high level of uncertainty avoidance include feelings of constant threat connected with a strong need for security, as well as the suppression of thoughts, opinions and behaviours that deviate from the norm. Aggression and emotions can be shown, time is money and numerous precise laws, rules and security requirements lead to a plethora of regulations and thus

greater formalisation. The uncertainty avoidance index scores Germany with the highest index followed by the Netherlands and then Indonesia.

Individualism: 6 countries in comparison (Based on Hofstede)

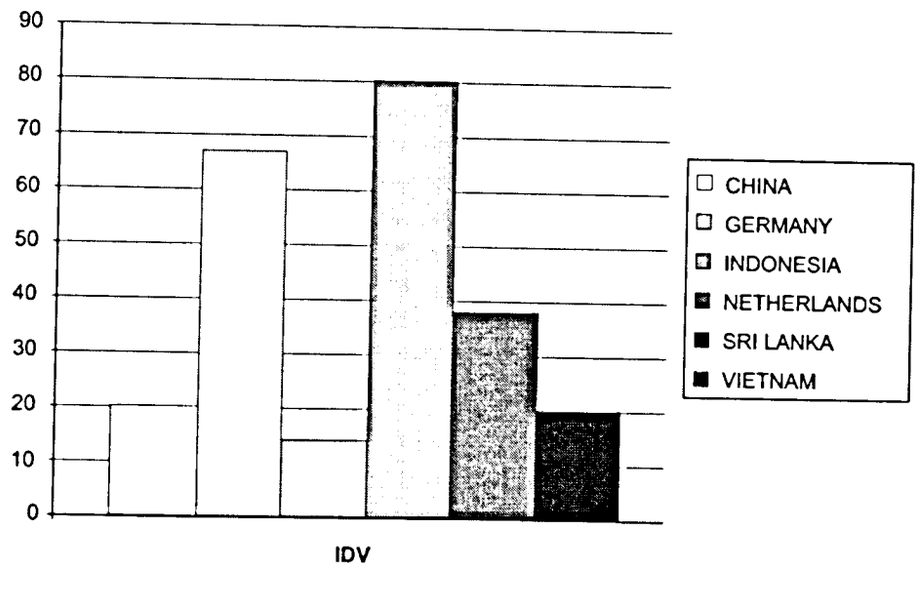


Figure: Individualism: 6 countries in comparison (based on Hofstede), at www.geert-hofstede.com, in alphabetical order by country.

The dimension of collectivism vs. individualism relates to the individuals in a group and their integration. In individualistic scenarios, bonds between people are loose, everyone looks after himself, and self-realisation and the expression of one's own opinion are the highest goals. Individual interests dominate and supersede collective interests. Tasks take precedence over relationships. The relationship between an employer and an employee has a specific aim. In a collectivistic scenario, the identity of an individual is based on his or her social network. Social consensus and the avoidance of conflicts are important foundations of this type of culture. The violation of these values and norms leads to shame and 'losing face', not just for the individual, but for the entire group. Collective interests dominate individual interests. Promotions are based on the principle of seniority, the relationship takes precedence over the task, and the relationship between employer and employee is morally grounded. Here again the European countries, Germany and the Netherlands,

have the highest score for the dimension on individualism, in contrast to the Asian countries, which tend to have a more collective context.

Masculinity: 6 countries in comparison (Based on Hofstede)

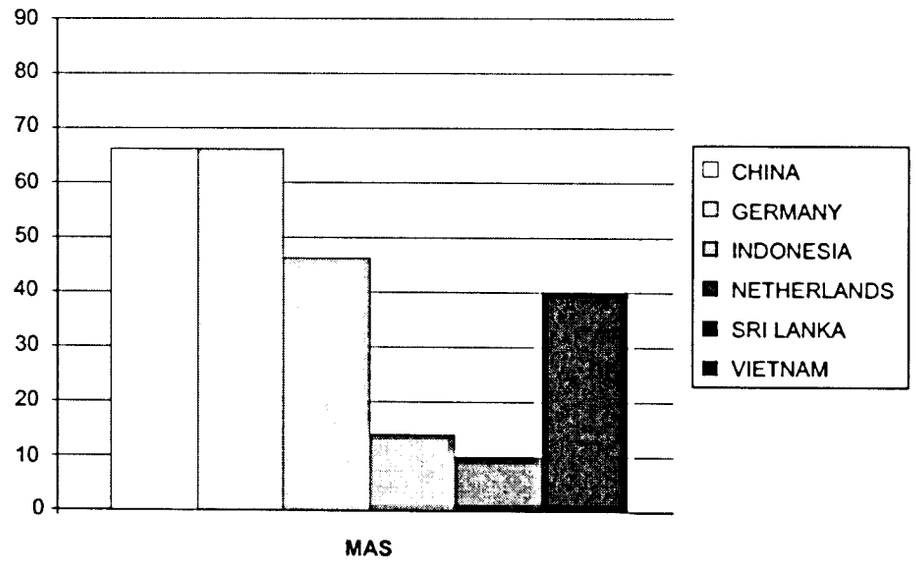


Figure: Masculinity: 6 countries in comparison (based on Hofstede), at www.geert-hofstede.com, in alphabetical order by country.

The categorical comparison of masculinity vs femininity on the basis of values and norms is explained as follows. Masculinity is associated with ambition, achievement and self-assertion, for example. Modesty, sensitivity and quality of life are considered to be examples of femininity. In a socially masculine context, the genders are clearly differentiated. Material success, advancement, progress, money, tangibles, achievement and sympathy with the strong are the most important parameters. Man lives to work; great value is placed on one's career, and conflicts are battled out. In diametrical opposition to this, cultures with a high femininity rating are associated with concern, individuals and their relationships. Men and women can both strive for equal rights. Men and women work to live, and conflicts are resolved through negotiation and compromise. Stress is placed on equality, solidarity and the quality of one's working life.

Long-term orientation: 5 countries in comparison (Based on Hofstede)

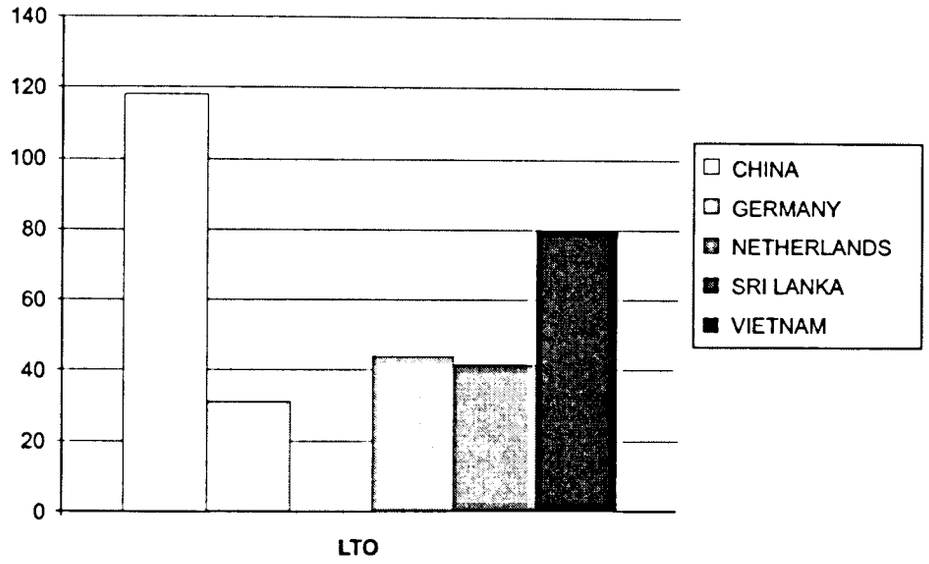


Figure: Long-term orientation: 5 countries in comparison (based on Hofstede), at www.geert-hofstede.com, in alphabetical order by country.

One can find high masculinity scores in China and Germany and followed by Indonesia and then Vietnam.
In addition to these four classifying dimensions of power distance, uncertainty avoidance, masculinity vs femininity and collectivism vs individualism, Hofstede expanded his model of different cultural concepts, after working with Eastern Asian countries, to include the dimension of long-term vs short-term orientation. Societies orientated towards the long term exhibit a belief in many truths, perseverance and the long-term pursuit of goals, as well as pragmatism and budgeting for the future. Values with a long-term orientation include diligence, perseverance and thrift. This is in contrast to a culture with a short-term orientation, which will have a tendency towards absolute truths, impatience, an aversion to heteronomy and strong normativism. Here again the differences run parallel to the geographically different regions. The Asian countries China and Vietnam have the highest score for long-term orientation.

5.2 Can Europe meet Asia and *vice versa*, or is it Squaring the Circle?

When a social group and its collective members are affiliated with a country, this community is endowed with a typical country culture or national culture, as well as identifying *characteristics or stereotypes*. Thus, needless to say, the acceptance of institutionalised culture as national culture frequently negates a country's multi-ethnic composition, minorities and majorities. In an Asian context, in particular, countries or nations will be linked to a specific country culture, but within this culture are heterogeneous and multi-ethnic associations of social groups. A knowledge of the culture of a country or nation and the historical dimension might determine actions taken during day-to-day cooperation in a project.

The *cultural diversity* in a country and between countries with different religions and language should not be ignored. Needless to say, national cultural stereotypes should always be critically examined (Carsten, P., 2002). What all countries in South and Southeast Asia do have in common is a phase of colonisation by European countries and many internal and international historical conflicts. Western Europe and its countries went through phases of social upheaval, and many violent conflicts as well. Consequently, one should not assume that 'Europe' is a monolithic bloc, based on homogenous occidental religious background, political and economic cohesion in the context of the European union. This also applies to Asian countries. Every project manager must be aware of the variable 'history' at all times and the variable 'homogeneity'. Even though there is a 'typical western European working style' one should not assume that the more homogenous that each team's cultural background is, the more cooperative the working relations will be. Experience shows that sometimes the more 'different' the 'other' party is, the more tolerantly one behaves (see R.D. Lewis, 2005)

Communication: While the European or Western style is open and discursive, in an Asian context informal rules are important along with personal relationships between partners and a culture of 'maintaining face'. These are the major cornerstones; this is the standard against which one's own work and the work of others is measured. Conducting themselves in line with these parameters, project partners confer respect, standing and leadership.

Religion: Viewed sociologically, religion is an institution holding people together. The members of a group need a shared idea, a value system and rites to create cohesion. In religion, believers find social stability, security and answers to questions of meaning. People are born into a religion, socialised in it and thus view it as a quasi-natural condition. Religion, functionally viewed, assigns values, gives meaning and serves to integrate people in a community, but it also acts as an instrument of social control. In the context of conflict theory, religion serves as a weapon and a distinctive feature between social groups, peoples and cultures. It also serves to maintain the established leadership, and it legitimises social and political systems of order for the ruling class in question (Feldmann, K., 2001).

The initial question raised as to whether Europe can meet Asia and vice versa, or whether it is a case of squaring the circle, can be answered with: yes, but not inevitably; and: no, if one is aware of cultural divergence and recognises at the earliest possible stage. Comparing the cultural concepts, religions and national cultures, the subculture, formal and non-formal rules of all participating countries combined, especially in retrospect, reveals 'mission impossible' standing in the path of cooperative project management. This is true regardless of whether one looks at the index for collectivism vs individualism or the index for long-term vs short-term orientation. The major roles played by religion and national culture in the partcipating countries, could not be underestimated and had a lasting influence on the project work.

There were divergences on all sides, not just in the comparison between Europe and Asia, but also within Asia and the Asian countries. Blind spots can be found among all participants. Just as differences and misunderstandings arise in teams within Europe, they will arise in the divergent and heterogeneous South and Southeast Asian regions, as well as from country to country. The problems facing international and intercultural projects are different, when compared to a culturally homogenous project: to formulate it more precisely, working in an international group has a different impact and scope in project management. Joint measures must be developed at the earliest possible point in a project in order to prevent surprises all around. It may also be a surprise that a target agreement or contract with specifications and set deadlines is more binding than a good personal relationship. However, European-Asian cooperation does not equate to squaring of the circle, if one is aware of itand recognises the differences at the earliest stage possible

Good preparation and a tolerant, open-minded environment strengthen the chances of project success. Cultural blind spots between geographically distant countries are not necessarily always barriers to cooperation. Even culturally similar partners may go through difficult phases in a project. The factors of social background, individual character, ethnic background and level of education are important for a partnership on equal terms too.

6 Concluding Remarks

This European-Asian project involving four countries from South and South East-Asia and two Western European countries made ist clear to all participants, that a certain degree of regional knowledge was crucial for successful co-operative project work. In a project with strong cultural divergences between regions, plus internal divergences within Asia and Europe, a basic knowledge of cultural groups and cultural concepts is crucial. The choice of partners, team-building processes and achievable project goals in keeping with everyone's interest is more important than strict organisation and micro-management. This means that the traditional project management model described at the start must be expanded to include the variables of culture and internationality. For the day-to-day work in the project, this means anticipating surprises, identifying sources of friction, sensitising oneself through a minimum of intercultural empathy and developing a good project and communication culture to ensure that the project is never managed with ignorance. The basic principles are:

Think Globally, Act Locally
'Think globally, act locally' was originally taken from global environmental discourse and is currently applied to the entire field of globalisation. This slogan hits at the heart of intercultural project management, particularly in the co-operation between South and Southeast Asian and Western European countries. 'Think globally, act locally' implies that (environmental policy) action and results will only come about if local structures and cultural differences are taken into account in the planning and, specifically, during the implementation. The slogan embodies the idea that, in an international community, it is important that: *'natural and social units maintain or recapture their identity, yet interplay with each other through a rich system of communications [...] Issues must be dealt with in their unique physical [...] and cultural contexts.'* (Eblen, R.A.; Eblen, W., 1994, 702)
'Think globally, act locally' could be a guiding principle for this European-Asian, global, multi-time zone and culturally heterogeneous research network. The success of this endeavour depended on trust, understanding and tolerance towards 'alien' cultures, a high degree of social competence paired with clear project components, pro-active but not dominant behaviour, and a tolerance for shifting project sub-goals. The path towards achieving the project goals is decentralised, local and can be chosen autonomously by the individual teams. Further, besides cultural differences based on geographical terms, it is important to consider the culture of research and sciences and its specific characteristics. There is great international competition in research and science. Solo attempts, individual interests and the need to increase one's profile is virulent. In the institutions as well as among the key players in the organisations, there is structural egoism which is inherently supported by the system and which can thwart all cooperation and teamwork. In research and science, the mantra of 'publish or perish' can mean that teamwork and work in a network might be

overshadowed by competition between individual scientists, scientific organisations or local scientific tructures. Project coordinators must therefore be aware of the local politics and culture in scientific organisations.

Acceptance in Dealing with 'the Other' - a Project Culture
The project culture is one of the most important social integration factors in international projects. Creating a 'we' feeling and ensuring culturally aware leadership through symbolic management prevents competitiveness and helps with communication difficulties and conflicts (Bormann, J.G., 1996).
In a European-Asian research project with teams from culturally, socio-economically and religiously heterogeneous countries, the greatest challenges are to avoid misunderstandings, to comprehend organisational backgrounds and to overcome cultural barriers or shocks. This calls for diplomatic skill from the project leadership, which is under a great pressure in terms of time and performance. It also requires the establishment of a project culture. In order to create a project culture and identity, attention should be directed during the 'take-off' phase to personal and group processes, which must be promoted through events, travel and personal meetings. The content, end products and goals must be discussed in the initial phase, but they must not be pushed to centre stage. The idea of community-building entails reaching trust in and through the community.

Cultural Understanding and Mutual Acceptance
In such a project, a strong focus must be placed on getting to know one's project partners. Evaluation of this project reveals the critical factor as being that too little attention was paid to team-building processes during the conception and planning phases. Not enough resources were set aside during the conceptual and planning phases for social activities. A project's budget should always include resources for regular meetings, and the infrastructure should support extensive video conferences or other communication support. The number of personal encounters in this project was reduced to the bare minimum of three group meetings in nearly three years, which sometimes did not promote enough collegial cooperation. A moderator or internationally experienced culture coach could have been involved in the first important phases of the project. The mutually impartial acceptance of all group members is a fundamental prerequisite for successful cooperation.

Communication, Communication, Communication and again Communication
Having a communication and a conflict management system which takes account of culturally based differences in ways of doing things is indispensable. Even when communication styles and ways of doing things differ on account of a heterogeneous group structure, communication must take place as an iterative process. This must entail communication between and amongst teams, and directly from the project office to the teams. Potential handicaps and barriers

must be discussed openly in a problem-oriented way. The project leadership must insist upon such open, problem-oriented communication if the team cannot or will not engage in such communication on its own.

A 'Code of Conduct' for an International Project
It could be noted that a constitution, a model and a vision are essential for a project. Every project needs to negotiate and discuss its own constitution, *modus operandi* or even *modus vivendi*. This may be initiated by the the project leader, or it may be proposed by the teams themselves. Conduct and trust are the variables which minimise centrifugal force in an international project. In the management literature and discussions, a 'muddling through' with respect to cultural heterogeneity is accepted far too often. Activities which help minimise cultural differences, promote community-building and enable the creation of a code of conduct are frequently the victims of commercial budget restrictions.

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Characteristics of the E-Learning Project 'Standardisation in Companies and Markets'

Features of a Project	**E-Learning EU-Asis Link Project Hamburg**
Non-recurrent and temporary	Period of 33 months, start 2004, end 2006
Complex Multimedia + new media in university teaching: Institutions: Content: Use of Internet and print media: Virtual network of globally distributed teams:	 E-learning, i.e., Internet - and computer-based teaching and learning; scientific work; Six European and Asian universities and associated partners from industry and from European and Asian standardisation organisations; Standardisation in Companies and Markets - interdisciplinary, with a focus on law, economy and technology Content generated once for two media: a) for publication online/on the Internet and b) textbook publication Trans-national and intercultural; a group consisting of 12 academics from engineering and business backgrounds, the project language is English
Interdisciplinary:	Lecture series developed by and for economists and engineers by experts in the country teams; support from the external expertise of the e-learning team for e-learning realisation
Limited, task-related budget: Restrictions, conditions and obligations in the distribution of resources +Cost-sharing model: 75% EU funds +25% own funds by HSU Hamburg	Total of EUR 407,000.00 divided into four instalments; a) permitted 10% overdraft of individual budget items with the exception of administrative and reserve funds; b) annual and quaterly reporting to the European Comission; c) release of instalments on a yearly basis only after careful examination by the European Comission and additional moitoring by an independent financial advisor

Novelty:	Classic topic of standardisation and norms approached using new media, based on e-learning and available via the Internet; additional publication of a textbook; produced in an international network with six teams from Europe and Asia
Working method: Process-like, organicg rowth, rarely possible to standardize and with the challenge of moving targets	Maximum six-monthly, monthly, frequently even just weekly planning; control through rough deadlines, milestones and a critical path, but shifting and modified by plans A, B, C
Project oriented leadership: Rejection of formal hierarchy, flexible and informal;	Interplay of teams which acknowledge informal leadership by a team leader without the existence of a traditional hierarchy to bestow status and position, the principle of an 'equal among equals' who offers advice, cooperation and participation
Project organization determined by tasks:	Exclusively through achievement of goals and orientation on results: 22 teaching and learning modules in an overall curriculum; necessary for the development and maintenance of a project culture

Figure: Characteristics of the E-Learning Project,Standardisation in Companies and Markets (© Siedersleben)

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