APEC Sub Committee on Standards and Conformance
Education Guideline 3 – Textbook for Higher Education

Standardization :
Fundamentals, Impact, and Business Strategy

Asia-Pacific
Economic Cooperation

Preface

"Ministers recognized the importance of standards education and encouraged members to develop reference curricula and materials to address the significance of standards and conformance to trade facilitation in the region."

- 2006 APEC Ministerial Joint Statement –

Noting the views expressed by the Ministers, APEC Sub-Committee on Standards and Conformance (SCSC), which has been working since 1994 to APEC Economies to address key issues in standards and conformance, initiated a project titled APEC Strategic Standards and Conformance Education Program in 2007.

This textbook is the third "Education Guideline" produced with the funding provided for the APEC Strategic Standards and Conformance Education Program. The first Education Guideline, '*Case Studies of How to Plan and Implement Standards Education Programs and Strategic Curriculum Model (APEC#209-CT-03.3),*' was published in March 2008. The second Education Guideline, '*Strategy for Education and Outreach on Standards, Conformity Assessment, and Technical Regulations (APEC#208-CT-03.3),*' was published in July 2009.

The objective of this third guideline, '*Standardization: Fundamentals, Impacts, and Business Strategy*', is to provide a common reference textbook on standardization for the graduate program in higher education in the APEC region. This textbook can also be used in the senior level of the undergraduate program as well as professional training for business managers and government officials. This textbook is an outcome of the APEC project CTI20/2008T jointly funded by the APEC and Korean Agency for Technology and Standards (KATS). The project of developing this textbook was proposed and managed by the Korean Standards Association (KSA). Since there are few textbooks on standardization, individual economies particularly developing economies were faced with the challenging task of developing teaching materials due to the lack of experiences and resources. Moreover, individual developments may cause the overlapping consumption of resources in fulfillment of the same goal. In this sense, we believe that the development of this teaching material will not only enable members to save time and efforts in the process but also build the fundamental bases for future education on standardization in the region, one that will increase public awareness in companies and public authorities in member economies in addition to universities; thus contributing to trade facilitation in our region.

No textbook is perfect and complete, and this third guide is no exception. Since this textbook is the publication of the APEC, we should explicitly include a full articulation of the relationship of this document to the work of the SCSC and the views of its members as follows. The chapters and case studies contained in this textbook were commissioned by the project editors to be developed and written by individual authors. The governments of the APEC member economies, including the co-sponsoring economies, do not endorse or take a position on the views or opinions expressed in '*Standardization: Fundamentals, Impacts, and Business Strategy*' and cannot guarantee the accuracy, relevance, timeliness, or completeness of information it contains. The views and opinions expressed in the chapters of this textbook are those of the respective authors. The contents of these chapters and case studies do not necessarily represent the views of APEC, the SCSC, and the member economies of APEC or the APEC Specialist Regional Bodies[1].

This book focuses on the fundamentals, impacts, and business strategies of standardization. Part I *Fundamentals* deals with the definitions and functions (chapter 1), lifecycles, organizations, and development procedures (chapter 2) as well as conformity assessment (chapter 3). Part II Impacts presents the economic impacts from the macro perspective (chapter 4) and micro perspective (chapter 5) as well as the legal impacts (chapter 6). Part III Business Strategy has four chapters – standardization and innovation (chapter 7), competitive strategy (chapter 8), collaborative strategy (chapter 9) and two case studies of information and communication standards (chapter 10). Three annexes are attached to this book. Annex A presents nine brief cases on how standards make a real difference in our society. Annex B discusses the role of the five APEC Specialist Regional Bodies. To provide students with tangible images of a standard, sample pages of ISO/IEC 27000 are embraced in Annex C. We should indicate that this book includes limited amount of contents and suggest the further development of teaching materials on conformity assessment and metrology in the future.

Finally, professors and teachers can gain additional teaching materials (power-point slides) and list of relevant references upon request. For those who plan to introduce this textbook in any sort of class, please contact the editor at dgchoi@ksa.or.kr for more teaching resources.

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1) Representatives from the APEC "Specialist Regional Bodies" (SRBs) participate in the SCSC as technical experts. The five APEC SRBs are: the Pacific Area Standards Congress (PASC), the Asia-Pacific Metrology Program (APMP), the Pacific Accreditation Cooperation (PAC), the Asia Pacific Legal Metrology Forum (APLMF) and the Asia-Pacific Laboratory Accreditation Cooperation (APLAC).

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Asia-Pacific
Economic Cooperation

Part I.
FUNDAMENTALS

Chapter 01

Definitions and Functions

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Learning objectives

After completing this chapter, you should be able to:

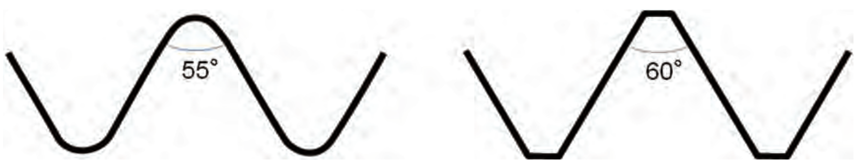
a) Understand what standard and standardization are.
b) Know the history of standardization.
c) Understand the functions of standardization and discuss its various functions.
d) Describe the different types of standards according to who authorizes it, what it is about, how it was developed.

Opening case: The Standardization of the Screw

A New York Times article commemorating the end of the 20th century selected the screwdriver together with the screw as the best tool invented for the past 1,000 years. No doubt, the screw is an indispensible technology relied on by all kinds of modern, man-made goods (Rybczynsky, 2001). Hashimoto (2002) has written extensively on the standardization process of the screw.

Henry Maudslay, a British tool and die maker known for inventing the screw-cutting lathe, is credited with coming up with the idea of standardizing screw threads around 1800. Until that time, screws were custom-made for each machine. By standardizing screws, they could be stockpiled and used interchangeably. Although Maudslay's idea gained gradual acceptance throughout Britain, the standards remained essentially "workshop-specific" screw standards, i.e., standards still varied considerably between companies and workshops. Joseph Whitworth, an apprentice of Henry, wondered whether all these standards could somehow be unified. He collected screws from companies across Britain and reported his findings to the Institution of Civil Engineers in 1841. Whitworth's proposal was to standardize screw threads by getting the average of the existing screws. Therefore, in a sense, finding the mean -- or the middle way -- was the very first standardization activity. Following his proposal, it was decided that the standard screw thread angle would be set to 55º. Interestingly, Whitworth was an enthusiastic proponent of the standardization of many other commodities as well. He advocated the necessity of standardizing railway cars and steam engines and criticized the Imperial measurement system in favor of a decimal system that would make industrialization more efficient.

Fig. 1-1► Whitworth Screw and Sellers Screw

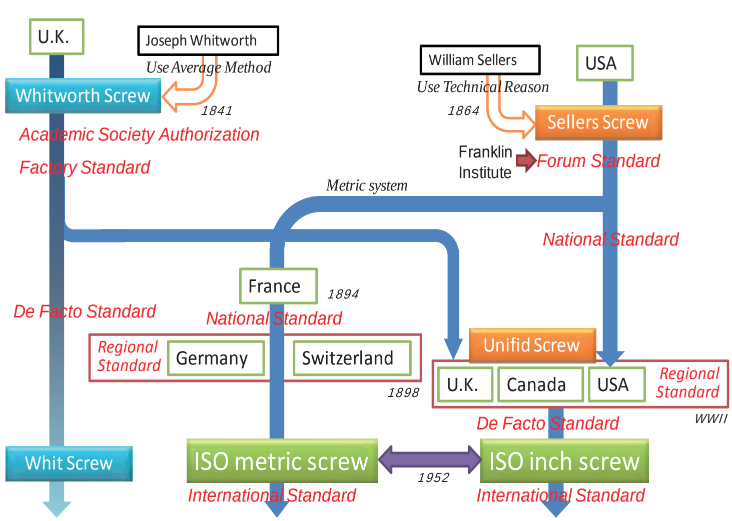


For the next 20 years or so, Whitworth's standard spread to many workshops and factories throughout Europe. The trouble with his standard was that machinists had difficulty producing the 55º thread profile, which had been determined by a simple averaging process. American engineer William Sellers reconsidered the standard thread from a technical viewpoint and proposed a 60º thread profile, which was easier to produce and was stabler. This new standard was standardized by the Franklin society, becoming the de facto standard in the United States after it was employed by railway companies and US's Navy Department. It was adopted as a national standard in the United States, United Kingdom, and Canada and later worldwide as the Unified Thread Standard. Seller's thread was adopted as France's national standard in 1894 and used as international standard for France, Germany, and Switzerland in 1898. Today, it is still used worldwide as the ISO screw thread standard.

Naturally, not all screws were standardized. Higher-quality, fine-thread screws were needed for steam engines, and coarser threads, for home steamers to simplify maintenance. Furthermore, left-handed screws were essential for safety purposes on rotary machines. In other words, standardization was limited by its objectives and the scope of its effective application. Note that Seller's thread -- which was originally specified in inches -- was converted into metric by the French for their national standard, and this eventually became an international standard. Nonetheless, the United States continued to use inch-based measurements. Even today, metric screws and inch screws are both widely circulated.

The Great Baltimore Fire of 1904 provides us with a salutary lesson on the history of the screw thread's standardization. The blaze that began on February 7 lasted for 36 hours and consumed more than 1,500 buildings, thereby causing damage worth USD 150 million dollars at the time in 1904. Immediately after the fire broke out, fire engines from Washington, Harrisburg, Wilmington, Philadelphia, Chester, New York, and other nearby cities rushed to the scene, but the out-of-town firefighters found that their hose couplings did not fit the threads of Baltimore's hydrants. As a result, they were unable to check the spread of the blaze. In a way, the Great Baltimore Fire's legacy was to spur the standardization of firefighting equipment -- especially that of hose couplings -- so that any hose could connect to any hydrant in the economy.

As we have seen above, the history of the screw's standardization is a long one. Nonetheless, it is still an important standardization area today. As the first seller of the Phillips screw in Japan, Topura Co., Ltd., has recently started to ask its customers to standardize their screw sizes. The company currently stocks more than 30,000 screw types, a number that has risen over the years as users demanded more custom variations. Through standardization, Topura hopes to slash its inventory to less than 10,000 screw variations. Consolidating screw types not only cuts the manufacturer's production and inventory costs; it can also be viewed as a form of "standardization" that plays a major role in reducing parts management costs on the client's side.



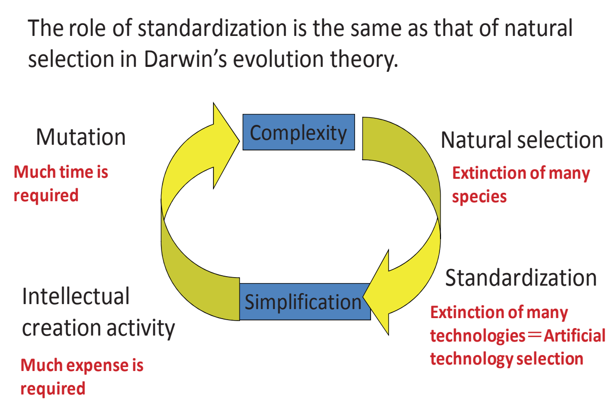
◀Fig. 1-2 Development of Screw Standards

1.1 History and Definitions

1.1.1 History

"Standardization is nothing new. It's an activity that's as old as the hills." Thus began an International Organization for Standardization (ISO) working paper (Sanders, 1972) drawn up in 1972 for ISO personnel. Indeed, standardization is a naturally occurring activity that predates human history. In his theory of evolution, Darwin described the cycle of biological evolution as the result of two contradictory forces: random mutations that diversify the living species and natural selection wherein only those mutations that are best adapted to their environment survive. Therefore, standardization is nothing more than a "selection" activity, the act of simplifying a phenomenon that would otherwise grow more complex if left to its own devices.

Fig. 1-3▶ The role of Standardization



There are numerous examples of naturally occurring standardization in human history: language, writing, many forms of tools and implements, and ceremonies and other social rituals. Through countless iterations and experiences, these aspects of life were gradually standardized and spread from person to person across broad geographical areas. "Language" is a salient example, illustrating both the benefits and limits of standardization. While languages have attained a very sophisticated level of standardization within certain well-defined areas, several hundred languages are still in use in the world today.

With human society growing more sophisticated, humans began to make use of standardization deliberately to build the underpinnings of their societies and cultures -- counting systems, weights and measures (units of length, volume, and mass), and currency systems were needed to negotiate the trade of goods. When we speak of "standardization" today, we generally refer to this type of man-made activity. Man-made standardization has a direct connection to the establishment of civilizations and rise of state power.

A prime example of early man-made standardization can be found in ancient Egypt. Erected around 2500 BC, the largest Egyptian pyramid was 147 meters tall, with sides that are 230 meters long at the base. Some three million stone blocks have reportedly been used in its construction. The ancient Egyptians were believed to have needed at least two standard-like concepts to construct such massive structure. The first was a standard unit of measurement, and the second was the idea of first planning the work procedures and subsequently carrying out the work following the work plan. This concept was the forerunner of our modern work standards. For instance, the agreed upon length and weight units were used to cut stone blocks consistently to the given dimensions. The unit of length at the time of the pyramids was the cubit, which was based on the length of a man's forearm. Even at the dawn of civilization, an era of standardization wherein humans would utilize uniform units and work operations within group activities could already be envisioned.

As technology advanced and standardization broadened in terms of scope, a multitude of standards whose character was similar to technical specifications emerged as a means of making mass production economically viable. This form of standardization exploded during and after the industrial revolution, becoming the technical foundation of the industry. Although Watt's steam engine and Crompton's spinning mule were the known driving forces behind the industrial revolution, businesses had undeniably been able to adopt rapidly the new motorized machinery precisely because of the standardization of production methods and products, which was underway at the time.

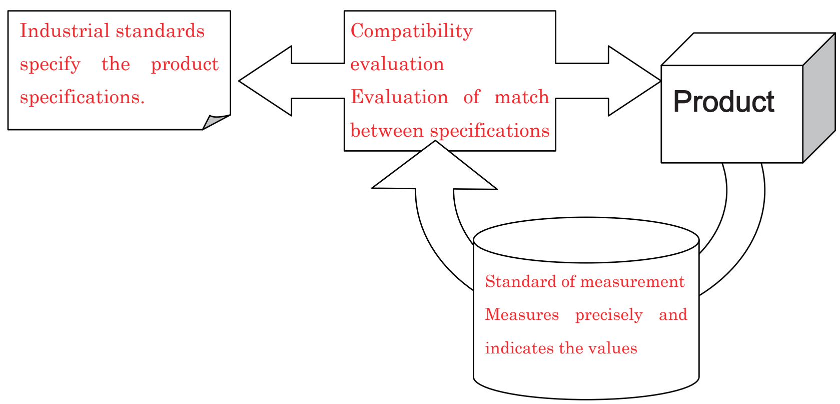
Standardization activities have always been vital in another field: government procurement particularly the procurement of weapons. Governments of all economies have had to procure large numbers of weapons of consistent quality, from musket firing locks to artillery shells (Fujino and Eto, 2009). Thus, governments have frequently employed standardization in weapons procurement and in civilian areas as well. Moreover, the sheer scale of government procurement has often caused the government technical standards to become the prevailing technical standards throughout society. Thus, government procurement -- or more generally, a dominant user of technical standards -- has driven the dissemination of standards and standardization itself.

1.1.2 Definitions

1.1.2.1 Document standard, measurement, and conformity assessment

The word "standard" covers a wide range. This word is used in various facets of industry, society, and life. While the standards handled in this textbook mainly fall in the category of "document standards," standards are being spread throughout various different fields such as agriculture, drugs, and medicines beyond the field of industry. Such standards are often called "industrial standards," and the act of making a document standard is called "Standardization." Material standards such as gene banks or reference materials and "standards of measurement" in the world of "measurement" are also important "standards." Although material standards and measurement standard are not discussed in this textbook, knowing the roles shared by these "document standards" (industrial standards), "standards of measurement" (measurement), and "conformity assessment" is inevitable in obtaining an overall picture of standardization. I would like to classify the relationship among these three in this section. Although subjects of standards range widely from objects to methods and systems, this section considers the industrial standards for "objects" to simplify the explanation.

Fig. 1-4▶ Standardization, measurement and conformity assessment



To indicate the specifications of a certain "object," there is a need for its length, weight, shape, etc., to be expressed. Specifying such units and terms is the most basic activity for standardization. Measuring the values of the specified units and terms to quantify them as correct values is called "measurement." Measurement can be considered the foundation for all industrial products since the determined specifications cannot be addressed if objects cannot be measured precisely. Reference standards play a big role in exact measurement.

If objects can be measured properly, they can be made uniform. "Industrial standards" determine the specifications to "make them uniform." Compatibility is delivered, and various social benefits can be realized by making them uniform. Such benefits will be described later.

Next, "conformity assessment" checks the specification compatibility, i.e., whether the manufactured "object" really matches the specifications provided by the "industrial standards" using measuring techniques. Industrially speaking, setting the "industrial standards" alone is not sufficient. "Conformity assessment" to check if the products comply with the specifications is inevitable in advancing the application of industrial standards since making products that comply with the standards is most important.

Although this textbook does not discuss measurement, "standard of measurement," "industrial standard," and "conformity assessment" make up the world of standards in a unified fashion as shown in Figure 1-4.

1.1.2.2 Standard and Standardization

The WTO/TBT agreement defines "standard" in Annex 1 as a "Document approved by a recognized body providing for common and repeated use rules, guidelines, or characteristics for products or related processes and production methods compliance with which is not mandatory. It may also include or deal exclusively with terminology, symbols, packaging, marking, or labeling requirements as they apply to a product, a process, or a production method."

ISO as one of the main SDOs defines the standard in ISO/IEC Guide 2 (ISO 2004-1) as a "document established by consensus and approved by a recognized body, providing 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." The guide also defines "standardization" as the "activity of establishing -- with regard to actual or potential problems -- provisions for common and repeated use aimed at the achievement of the optimum degree of order in a given context."

Based on the WTO/TBT agreement, the difference between these two definitions is explained thus: "The terms as defined in ISO/IEC Guide 2 cover products, processes, and services. This Agreement deals only with the technical regulations, standards, and conformity assessment procedures related to products or processes and production methods. Standards as defined by ISO/IEC Guide 2 may be mandatory or voluntary. For the purpose of this Agreement, standards are defined as voluntary, and technical regulations, as mandatory documents. Standards prepared by the international standardization community are based on consensus. This Agreement covers even documents that are not based on consensus."

Note that the both of WTO/TBT and ISO definition refers to "standardization" as the activity of "establishing" a standard; a "standard" must be a "document" and "approved by a recognized body." This is a much narrower definition than how the general public uses the word "standard." Frankly speaking, the both definitions really make sense only to standardization experts.

From the general public's standpoint, whether a "standard" is documented or not is not important; neither does the public have any need for a "recognized body" to create the standard. What is meaningful to it is whether the dissemination and use of a given standard will promote community benefits or whether disregarding the standard will pose disadvantages. The definition that probably captures the general public's intuitive feeling about standards most closely is "an entity that defines rules, guidelines, or characteristics" leading to improved community benefits. Such definition encompasses the de facto standards and legal regulations as well. Section 1.3 covers the different outcomes arising from various ways of creating these standards.

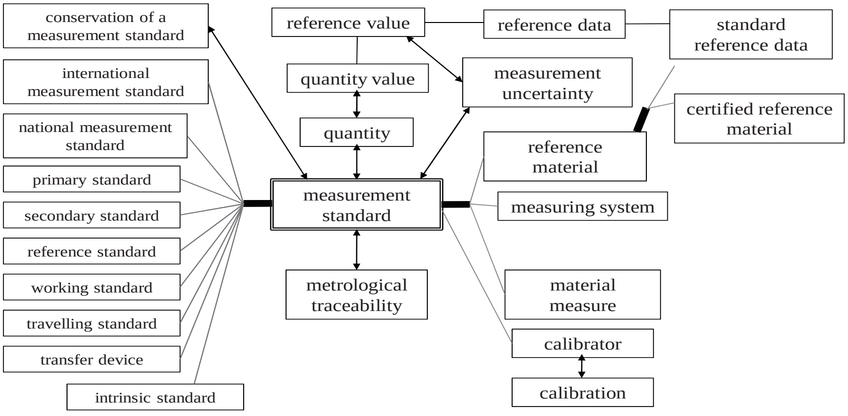
1.1.2.3 Measurement Standard

Measurement involves measuring with a specified scale; ideally, the measured value should be identical regardless of where in the world it is measured. Therefore, government organizations of various economies take the initiative in establishing systems to make the measurement results uniform; these systems address the standard of measurement.

To measure correctly is a purely scientific and technical process; research and development to measure correctly are still progressing. Nonetheless, obtaining a perfect value is difficult, and the degree of value correctness can be indicated by defining the concept of "uncertainty."

Such terms in measurement are described in VIM: International Vocabulary of Metrology jointly prepared in 1984 by the Bureau International des Poids et Mesures (BIPM), International Electrotechnical Commission (IEC), International Organization for Standardization (ISO), and Organisation Internationale de Metrologie (OIML); the third version (VIM-3) is currently issued as ISO/IEC Guide 99 as of 2007 after the second version from 1993. A conceptual drawing of the standard of measurement included in the Annex of this vocabulary is shown in the diagram. While there are various terms with "standards" in the world of measurement standards as indicated by this diagram, they will not be covered by this textbook.

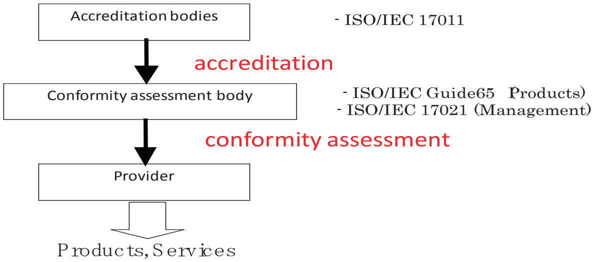
Fig. 1-5▶ Measurement Standard (VIM 3rd edition A12, ISO/IEC Guide 99,2007)



1.1.2.4 Conformity Assessment

The WTO/TBT agreement defines the "conformity assessment procedures" in Annex 1 as "any and all procedures used -- directly or indirectly -- to determine that the relevant requirements in technical regulations or standards are fulfilled." "Conformity assessment procedures include inter alia, procedures for sampling, testing, and inspection, evaluation, verification, and assurance of conformity, and registration, accreditation, and approval as well as their combinations" is added as an explanatory note. Terms such as conformity assessment and accreditation are also defined in ISO/IEC 17000. Conformity assessment -- Vocabulary and general principles (ISO/IEC 2004-2).

Fig. 1-6▶ Conformity Assessment System



In the ISO definition, conformity assessment is defined as a demonstration that the specified requirements related to a product, a process, a system, a person, or a body are fulfilled. Simply put, conformity assessment is the activity of establishing whether the target product, process, system, person, or body matches or fulfills the requirements of the entity that defines rules, guidelines, or characteristics, to borrow our definition of standard as developed in the previous section. The organization that performs conformity assessment is called a conformity assessment body As for the requirements for a Conformity assessment body, different standards for each field are maintained as shown in Table 1-1. For instance, ISO/IEC 17021 (Conformity assessment -- Requirements for bodies providing audit and certification of management systems stipulating the capabilities) has the requirements for the accreditation bodies of the management system; it sets the requirements for a conformity assessment body that performs the certification of management systems.

The term accreditation refers to “third party attestation related to a conformity assessment body conveying a formal demonstration of its competence to carry out specific conformity assessment tasks.” (ISO/IEC 17000:2004) The “authoritative body that performs accreditation” is called an accreditation body. (ISO/IEC 17000:2004) The conformity assessment system provides accreditation bodies assessing that each conformity assessment body (CAB) meets the capability requirements to carry out conformity assessments properly and subsequently accrediting the CAB for compliance with the relevant standard (e.g., ISO/IEC 17025 for laboratories). The existence of these accreditation bodies is an integral part of the conformity assessment system. ISO/IEC 17011. Conformity assessment -- General requirements for accreditation bodies accrediting conformity assessment bodies sets the requirements that must be met by accreditation bodies in their operation.

Note that although the accreditation of conformity assessment bodies by accreditation bodies is part of the conformity assessment system, the accreditation bodies themselves are not conformity assessment bodies.

◀Table 1-1 Function of conformity assessment and ISO/IEC documents

	Testing and Calibration	Inspection	Product Certi-fication	Management Systems	Personnel Certification
Requirements for accreditation bodies	ISO/IEC 17011: 2004				
Requirements for bodies pro-viding audit and certification	ISO/IEC 17025	ISO/IEC 17020	ISO/IEC Guide 65 (revising)	ISO/IEC 17021	ISO/IEC 17024

1.2 Functions

While the three elements -- document standards, standard of measurement, and conformity assessment -- were discussed as the range of standards in the previous section, the functions of “document standards” are organized in the following section. The word “standard” in the following section indicates the document standards. Although this textbook does not deal with the standard of measurement, conformity assessment shall be discussed in Chapter 3.

1.2.1 Objectives and Value

At a fundamental level, the objectives of standardization are the dissemination of scientific and technical outcomes and extension of community benefits through mutual understanding within society and assurance of public order. At a higher level, however, the objectives and significance of standardization are manifold. Even a single standardization project usually encompasses multiple objectives.

1.2.1.1 What is Standardization?

Standardization is simplification. The foundation of standardization is simplifying certain things that would otherwise grow complex if left alone, thereby raising the degree of interoperability among things. Simplification brings about cost efficiencies and increased convenience.

Looking at it another way, standardization means taking the middle way. Standardization is the act of finding the mean or average of competing ideas and consolidating them into one to simplify two things or several things. De facto standards -- which we will discuss in depth later -- are different in this sense because they are established by rolling all competing ideas into the most dominant idea instead of finding the middle way. Aside from de facto standards, however, the so-called consensus standards are established through discussions aimed at finding the middle way. This process realizes the largest aggregate cost savings for the market.

1.2.1.2 Benefits and Limits of Standardization

There are many secondary benefits of standardization, two of which are efficiency gains and economic advancement. More specifically, standardization is expected to deliver benefits including the following: (1) faster information communications and greater precision; (2) development of understanding among retailers and consumers at an earlier stage; (3) mitigation of conflicts between manufacturers and consumers; (4) enhancement of maintenance and repair efficiencies, and; (5) effective prevention of the recurrence of problems or accidents. When standardization costs outweigh the standardization benefits, however, the result is neither efficiency gains nor economic advancement. In such case, standardization should be avoided.

Furthermore, people will obviously not accept standards for products wherein personal taste, choice, preference, or usability is involved, e.g., clothing designs, which are subject to personal taste and preferences. Products like these should not be standardized. The same applies to matters of national secrecy (e.g., defense). In other words, standardization is not for everything; it has definite boundaries.

1.2.1.3 Other Standardization Concerns

In addition to the limits to standardization as discussed above, and in view of the objectives and benefits of standardization, standardization in general should only cover the major provisions related to the standard's target; it should not attempt to regulate every side issue. For instance, a national standard trying to ensure the interoperability of a part should define only the minimum required dimensions for safety and interoperability and refrain from placing restrictions on any other dimension.

For standards for finished goods or raw materials, the ordinary standardization of only the material quality and testing methods will suffice. Defining the manufacturing methods, for example, is not appropriate because this will impede the progress of the manufacturing technology. When product quality or safety cannot be guaranteed without a regulated manufacturing method, however, defining manufacturing methods and related particulars is appropriate.

For the sake of not hindering technical progress, the provisions of standards should usually focus on performance whenever possible and eschew provisions on design such as appearance or shape and provisions on specifications including dimensions or materials. Moreover, when drafting a national standard, the standardizing body must work to ensure that the standard will be internationally acceptable so as to eliminate unnecessary trade barriers.

Caution must be exercised with company rules on matters such as work procedures. If the rules are unnecessarily detailed or strict, observing them may be impossible, or they may impose excessive burden on enforcement and management.

Another important consideration is maintaining consistency between the provisions of all standards and avoiding contradictions whenever possible. Remember, contradictions between various standards not only run counter to the objectives and benefits of standardization but often lead to misuse as well.

Before embarking on a standardization project, clearly defining the objectives and end purpose of the project and subsequently proceeding with these in mind are essential. Standardization is a very human activity. In light of standardization's purpose, i.e., to promote community benefits, it goes without saying that the standardization benefits will not be manifested if rules and criteria are established but people and organizations do not observe them. If standardization is not bearing fruit because of problems in the rules or agreements, then rethinking the rules may be necessary.

1.2.2 Basic Functions

1.2.2.1 Controlling (Regulating) Diversity

The most basic function of standardization is controlling diversity through simplification. If products are left to continue to increase in number in an uncontrolled manner, their complexity and diversity will get out of hand. That is why optimizing the categories of products (or processes or services) while fulfilling the needs of the vast majority is crucial.

The standardization of battery sizes from AAA to D cells, for instance, lets consumers easily select the correct battery size and allows producers to save on raw material costs and production plant costs.

Controlling (regulating) diversity translates into higher production efficiencies. A typical car uses some 4,000 ~ 5,000 parts. Despite this number, rules govern the shape and performance of every screw, bolt, nut, spring, and other mechanical component. There are rules for the auto body panel materials, plastics, and rubber composition of the tires. Parts standardized by rules or regulations can be mass-produced very cheaply, enabling even the mass assembly and production of cars. In the end, standardization improves production efficiencies so that automakers can sell cars to consumers while minimizing the per-unit production costs.

Still, what should not be overlooked with this type of standardization is giving adequate leeway for technical growth and refraining from unreasonably limiting technical innovation. Simplification by reducing the number of categories is important when controlling the diversity of an item, which would lead to chaos if left unregulated.

1.2.2.2 Ensuring Interoperability

Together with controlling diversification, the most important function as realized through simplification is ensuring interoperability.

When putting parts together, replacing parts or products, or connecting software systems, failed interconnections or their adverse effects are exceptionally inconvenient and uneconomical. The fact that we are able to fit a nut to a bolt, easily replace a fluorescent bulb, get consistent results from program languages or data processing functions, and connect computers over the Internet is credited to standardization.

Interoperability consists of dimensional interconnectivity and functional interconnectivity. The nut and the bolt are an example of dimensional interconnectivity, and computers, of functional interconnectivity.

An extension of ensuring interoperability is furthering mutual understanding. In society, we ordinarily communicate our wants and opinions to others so that they can understand us. To do this, however, we require a standard form of communication.

Language, symbols, and blueprints are all examples of standardized communication; thanks to standardization, we can readily understand direction markings, safety symbols, and blueprints anywhere in the world. For example, the SI weights and measures have eliminated the need for conversions and made technical formulas consistent, since SI units are used universally in all technical fields.

1.2.2.3 Compatibility

We said early on that standardization involves taking the middle way. Finding the middle way is important when faced with competing technologies, not between similar technologies or similar products. The ideal scenario is the existence of capability to use multiple products, processes, and services together under the given conditions, with each satisfying its own requirements and without unreasonably affecting others. Such capability is the realization of compatibility.

For example, this applies to the relationship of mobile phones and electric wheelchairs with pacemakers in the field of electromagnetic compatibility. In a sense, implementing compatibility can be considered establishing interoperability between devices with separate purposes. In either case, the easiest way to understand standardization is to view it as the implementation of interoperability through simplification.

1.2.2.4 Assuring Quality and Safety

Many people quickly cite assuring quality and ensuring safety as the two benefits of standardization. Note, however, that these are not realized solely through direct benefits from standardization. As we have described earlier, what standardization does is to unify quality and safety. Only when the unified level is sufficient are quality and safety ensured.

Standardization per se does not foster high quality or high safety levels. Unification is an important function for the industry regardless of whether the unified level is stringent or relaxed. For example, standard Japanese steel products are of identical quality regardless of the manufacturer. Although there are many steel products of higher quality overseas, it is better for corporations to be able to obtain products of consistent quality from multiple suppliers than to be able to obtain products of higher quality, at least from the standpoint of business continuity. Thus, standardization is valuable precisely because it simplifies product quality. To conserve scarce resources during World War II, Japan set equipment standards to very low levels that the equipment barely met its minimum required functionality. This is an example of deliberately standardizing poor quality. The same holds true for safety standards, which shall be discussed in more detail below. The key lesson here is that the value of standardization lies in its ability to unify safety and quality.

1.2.3 Expanded Value

1.2.3.1 Ensuring Corporate Interests

One role of standardization that we cannot neglect is its benefit to corporate activities. In this section, we give an overview of the relationship between corporate interests and standardization. Chapter 8 takes a closer look at corporate standardization strategies.

1. Cheaper Production (cost reductions)

Let us first consider cheaper production. There are many possible innovations in manufacturing products more cheaply: developing and designing products inexpensively, sourcing raw materials cheaply, reducing labor or maintenance costs to save on production expenses, or even cutting down distribution costs. Let us see how standardization can benefit each of these areas.

(1) Cost reductions through in-house standardization

The easiest standardization benefit to conceptualize is the standardization of production processes, which reduces costs through the more efficient use of machinery and personnel. These are simply productivity gains from standardization. Standardization activities are the reason production line workers at many automakers are able to produce several models concurrently.

Taking another step by modularizing car frames, for instance, cuts down expenses by reducing the total part counts. The more complex the assembly process is, the more likely the standardization of components -- such as screws and springs -- can reduce part counts and consequently save on related costs.

(2) Cost reductions through industry-consensus standardization

We have talked about the benefits of in-house standardization. If an entire industry can agree to standardize the parts, materials, or production equipment used throughout the industry, however, we can expect even lower procurement costs due to intensified, market scale-driven price competition. An illustrative example is the semiconductor industry's standardization of wafer transfer systems in keeping with the introduction of wafers with diameter of 300 millimeters. Retooling a production line to accommodate a wafer size change is an enormous investment. To mitigate these costs, the semiconductor industry globally agreed to develop and standardize a common 300-millimeter wafer transfer system. This concerted effort — by expanding the industry's buying power and inducing price competition among suppliers — is said to have slashed transfer system prices by 75 percent. Clearly, an important application of standardization is to standardize goods or equipment that one regularly procures to trigger price competition and in turn cut down one's purchase costs.

As shown by the semiconductor wafer example, industry-wide standardization not only lowers the procurement costs but also cuts down the development costs by sharing them among a number of firms. Furthermore, if an entire industry agrees to use the standardized products, standardization can virtually do away with a portion of the ongoing technical development costs since firms no longer need to compete or invest in that area. Standardization also lowers market entry costs considerably for later competitors. This has massive impact on standardization's ability to expand markets, which shall be discussed later.

If an industry can agree on standardization, there can be cost benefits to suppliers because they only have to produce one standard product per category instead of multiple client-specific products. This is why switch manufacturers participated in the standardization of optical connectors led by NTT. Connector standardization benefitted these manufacturers because they no longer had to produce and support a variety of connector types.

(3) Cost reductions using standardization and certification

Certification is a third-party attestation (statement) that a product, a process, a system, or a person meets the specified requirements. (ISO/IEC 17000:2004) We shall discuss this topic in detail in Chapter 3. Corporations can use certification to realize cost savings. By purchasing certified products or parts or materials with certified quality, companies can avoid or lower acceptance inspection costs when procuring manufacturing materials. Similarly, purchasing from corporations that have acquired ISO 9001 or other quality management certifications can also save businesses money in a similar manner.

Another important area is cost reduction resulting from the acquisition of certification for shipped products. As we shall see in Chapter 3, product certification and other conformity assessments contribute to product differentiation. As such, there is a tendency for businesses to believe that acquiring certification will incur certification costs that will offset the higher prices that they can get for their products due to differentiation. Nonetheless, most certification systems in practice are operated as systems to validate that products meet the minimum required quality or safety levels, and their purpose is not to differentiate products. When there is no cap on a product's quality or safety levels, companies invest heavily in competing in this area. If standard rules apply to quality and safety, and your products fulfill the standard's requirements and acquire the corresponding certification, however, then there is less need to invest further in quality or safety.

One consequence of this is that you do not require standardization in areas where you want to differentiate your products. For example, there is no movement to standardize the product safety of passenger cars wherein most of the functions are already standardized, with linear competition focusing on fuel economy and safety.

(4) Assessing the cost reduction benefits

Standardization bodies, etc., have performed many analyses on the cost reduction benefits of standardization. This shall be discussed in Chapters 4 and 5 in more detail. ISO started a project in the second half of the 1970s to demonstrate widely the advantages of standardization. After reviewing 17 past documents, a report was completed in 1982 (ISO 1982). Taking a quantitative approach, this report defined the cost savings realized through standardization as "standardization income" and the expenses incurred by standardization activities as "standardization costs" and compared these two to determine the benefits of standardization. In 2000, German institute DIN published Economic Benefits of Standardization, (DIN 2000) a report that looked at the advantages of standardization for businesses from various perspectives. The report concluded that standards were useful in reducing costs in production, sales, and R&D activities in majority of the cases. In a report distributed to small and medium-sized businesses (UNIDO, 2006), the United Nations Industrial Development Organization (UNIDO) used four indices — manufacturing process rationalization, materials and labor economization, curtailing of materials and finished product counts, and lowering of manufacturing costs — to measure the benefits of standards to manufacturers. UNIDO concluded that standards had a noticeable cost reduction effect.

No doubt, reduced costs are the most typical and overt benefit of using standardization. Note, however, that much of the shared cost savings resulting from open standardization within an industry are in fact brought about by market expansion as another important function of standardization. In other words, the direct benefits of standardization's market expansion effects are regarded as cost reductions, not as expanded revenue. To understand this idea better, let us look at market expansion, which is perhaps the true primary function of standardization.

2. Volume Selling (creating, expanding, and sustaining markets)

In this section, we shall break down the mechanisms and influence that standardization has on market creation, expansion, and sustainability. Our examination can be divided into three major parts: first is the creation and growth of a market; second is the expansion of the market for a product by advancing into other markets; third involves sustaining an established market for as long as possible.

(1) Market creation and expansion through growth

Two main mechanisms operate, through which standardization creates markets. The first mechanism is that standardized products give purchasers confidence in terms of the product's quality, safety, and long-term supply stability. When the purchasers are ordinary consumers, the sense that the product will be a mainstream product is a huge driver in expanding the market. As the second mechanism, a standardized product lowers the technical barriers to entry for suppliers because the technology becomes public, and there are fewer product categories to deal with; moreover, since the product is more likely to be mass-marketed, there is less risk of market failure. Normally, in practice, once consumer numbers increase beyond a certain threshold, and customers are apparently giving preference to standardized products, many businesses will jump into the market; thus causing it to grow dramatically. Such effect is called "network externality" (Katz and Shapiro, 1985), which shall be explained in Chapter 8.

With more technical areas simplified or stabilized by standardization, the market expansion effect will naturally widen. If we can discount user diversity or individual demands, standardizing every specification of a given product would maximize the market expansion effect. In other words, in getting the biggest market expansion bang from standardization, one would try to gather as many like-minded partners as possible and standardize the entire product in as much detail as possible. Bicycles and sewing machines are the epitome of this approach. Many believe that standardization is to be credited for the growth and expansion of Japan's bicycle industry and sewing machine industry and their becoming internationally competitive. For example, nearly all bicycle parts are standardized in exacting detail. Therefore, even if your company manufactures only one type of handle grip, your handle grip will likely fit majority of bicycles. In other words, you can enter the bicycle industry -- a huge export industry -- just by producing one type of handle grip. Because of such part standardization, numerous small and medium-sized businesses have entered the Japanese bicycle industry and served as the drivers propelling the development of the entire industry.

Nonetheless, market expansion is not directly tied in to business revenues. The cost reduction effect we discussed earlier is by itself business revenue. Still, market expansion is the expansion of the total market for the product; it is absolutely not equivalent to expanded sales for each market player. If your firm's product share shrinks, your revenue may be adversely affected even if the market expands. Worse, your revenues may fall even if you retain your market share in case standardization allows into the market more new entrants that drive down prices through manufacturing or technical innovation. Of course, the lower prices are a bonus for users; as we said before, lower prices lead to further market expansion. Nonetheless, they also spell lower profit margins for manufacturers. The Japanese bicycle industry is known to have lost majority of the domestic market with the elimination of bicycle tariffs and a simultaneous influx of inexpensive, foreign-made bicycles. The disadvantages -- as shown in this example -- associated with standardization are tackled in depth in Chapter 8.

(2) Market expansion by connecting to new markets

Another way by which standardization expands markets is by connecting markets through the establishment of interface standards. A new market can be opened for a certain product by developing an interface standard with another market wherein the product is not used.

The IBM PC was sold as an office computer and was widely used for business applications. By selling PC-AT with the standardized AT bus that many peripheral devices could interconnect with, however, IBM was able to enter new markets related to music and images.

Another example of this type of lateral market expansion is the digital camera. The digital camera was born as a computer peripheral device; digital camera images were stored in a computer and printed on a computer's printer. When the memory card file format was standardized including the format for exchanging data with print shops, however, consumers who did not own a computer were able to buy and use digital cameras. Through standardization, the digital camera industry freed itself from the computer market and completely overwhelmed the film camera market. Similarly, with the standardization of the printer interface, cameras could directly connect to printers. For printers, this meant gaining access to the massive digital camera market as well as the computer market. Since the high-quality printers that work with digital cameras are not susceptible to the same price competition as entry-level computer printers, the standardized interface has actually revitalized the printer industry.

Establishing interface standards and expanding into a market where the product has not been used before is an important market-opening technique and is a standardization function that should not be overlooked when employing standardization in business activities.

(3) Long-term market expansion

At some point, businesses must start thinking about expanding the market as an integral value as well as increasing the market size. In other words, developing a business strategy to extend the life of products and maintain the market over a long time period becomes essential. The lock-in effect of standardization has a big role to play in this strategy (Shapiro and Varian, 1999). When standardization drives market expansion, the higher the product's market share is, or the bigger the costs of training to learn how to use the product are, the further the product will be locked in by standardization, and the more likely the market will remain stable on a long-term basis. For this reason as well, market expansion through standardization is an important strategy.

The downside of the lock-in effect is that it acts as a barrier to the introduction of new technologies. Therefore, we must remember that standardization can pose a disadvantage to leading, innovative producers and early adopters.

The negative outcomes of the lock-in effect are frequently seen in the software industry particularly in word-processing software and spreadsheet software. Perhaps the most famous example is the QWERTY keyboard. The key arrangement on the QWERTY keyboard was deliberately chosen partly at the expense of typing efficiency due to technical constraints at the time of its emergence in the 1870s (Yasuoka and Yasuoka, 2008). As typewriter technology progressed, though, more efficient keyboard layouts were developed. One of these was the Dvorak Simplified Keyboard patented in 1932 and designed specifically to maximize typing speed in English (the QWERTY keyboard will be discussed as the Opening Case of Chapter 2).

Despite the emergence of better keyboard layouts, the QWERTY layout remains the dominant layout even in the computer age because the cost of retraining people to type on a different keyboard has been deemed too high. We will tackle further these kinds of barriers to technical progress as created by standardization in Chapter 7.

3. Selling at Higher Prices (product differentiation)

(1) Differentiation using certification

As we have discussed so far, standardization is well-known as a major contributor to cheaper production (cost reductions) and volume selling (market expansion). When it comes to selling products at higher prices (by product differentiation), however, product standardization acts as an obstacle. This is natural, of course, since product standardization is an activity that moves toward homogenizing goods (eliminating differentiations). When combined with certification, however, standardization can be used to differentiate products.

As we said before, most product certifications are a guarantee that a given product meets certain minimum required quality or safety levels. Usually, acquiring certification is not actively tied in to product differentiation. If the quality or safety levels are set so stringently that only a few producers can achieve them, however, certification does contribute to product differentiation. One typical example is the BAA logo system run by the Bicycle Association of Japan (Eto, 2007). The BAA system certifies only those bicycles that pass rigorous safety inspection criteria as a means of differentiating bicycles made by Japanese manufacturers from lower-quality ones made in China and other economies. Consumers can use the BAA logo as a guide to selecting very safe bicycles in the Japanese market, which has been flooded by imports. The Four-Star logo -- which can be displayed on building materials, paints, and other products with low formaldehyde emissions -- also plays a huge role in product differentiation. Furthermore, the certification of compliance with ISO 9001 as a standard for quality management systems is considered to be somewhat effective in differentiating not the product but the business manufacturing it.

(2) Differentiation using testing standards

In essence, the BAA logo system and the Four-Star logo system are less of product standards and more of product testing standards; if a product meets a certain value, it passes. From this, we can easily figure out the huge role that testing standards can have in product differentiation.

Testing standards are one kind of method standard as described in Section 1.3.4.2 and are used to test and inspect specified performance levels and properties of products. These kinds of standards are very useful in helping supplant traditional products as market forms. These standards should always be established when introducing products that use a new technology to perform the same function as existing products -- for example, rolling out fluorescent lights in a lighting market where only incandescent lights are available.

Testing standards -- which are effective in driving market expansion as the market is created -- function as drivers of product differentiation in the later market saturation stage. Looking at our fluorescent light example again, we can see that the growth of the fluorescent light market prompted manufacturers to start using the same testing standards to highlight the superior performance of their fluorescent lights. In this context, testing standards have become a key factor in product differentiation.

Based on our discussion so far, testing standards -- which promote product differentiation - would seem more advantageous to businesses than product standards that impede product differentiation. Testing standards have one serious drawback, however: they make it easy for others to reverse-engineer your technology. Of course, product standards -- which normalize the very specifications of your product -- make it easy for anyone to imitate your product unless you come up with some special performance standards. Nonetheless, the objective of most product standards is to facilitate technology transfers; therefore, making technology transfers easier is not necessarily a demerit.

What testing standards do, however, is test or inspect the most critical technical elements of your product, the very source of your product's differentiation in the market. Therefore, disclosing the testing methods of the core of your product is equivalent to disclosing the goals of your technical development. Since goal setting is the most difficult part of R&D and technical development, knowing your technical development goals will help your rivals in their R&D activities considerably. Thus, taking into account the downside to testing standards when considering when to use product standards and when to use testing standards is crucial.

4. Merits and Demerits of Standardization

So far, we have looked at the impact of standardization from the perspective of corporate business activities. Table 1-1 lists the merits and demerits related to product standardization, which has the closest connections to corporate activities. As shown in the table, one has to weigh the many positive and negative effects of standardization on business before utilizing standardization in one's business activities.

The key point is that although standardization promotes market expansion, it also carries the huge risk of price wars and price erosion since product differentiation becomes more difficult. Another way of putting it is that standardization activities do make significant contributions to industry growth on the whole for all standardization players but also weaken the competitiveness of individual corporations. To prevent this situation, a corporation must keep its core competency areas outside of the scope of standardization by other corporations. If it succeeds in doing so, the corporation can sell its products at a higher price based on product performance in an expanding, standardization-driven market and avoid price wars. On the other hand, if all the players become embroiled in price battles, no one will profit from the market.

Another essential quality of standardization activities is that their outcomes cannot be withdrawn; once standardized, an area remains standardized for all time. A standard is only modified when a new, game-changing technology vastly improves on the current one. Until this happens, the standardized technology remains a public property that anyone can take advantage of inexpensively. As a result, if your firm cannot immediately put a standardized technology to use, your firm may be the only one at a disadvantage. This is an important point to remember; corporations must link their standardization activities and business activities after fully ascertaining the potential impact of standardization on their business.

Table 1-2▶ Merits and Demerits of Standardization

	For the supplier	For the purchaser
Merits	Lower entry costs Lower production costs Lower R&D costs Market expansion and long-term stability	Lower procurement costs Stable procurement volumes and quality
Demerits	Discloses the technology Complicates product differentiation Lowers prices Difficulty in developing markets for non-standard goods	Fewer product options Difficulty in replacing the introduced products

1.2.3.2 Achieving Policy Goals

Quality improvements, production efficiency advancements, and other forms of production rationalization be they for industrial products, agricultural products, or other products, fairness in trading, usage, expansion of imports, and rationalization of consumption all fall under the scope of government policy. This is why achieving policy goals is considered one of standardization's objectives. Some policy objectives connected to standardization include "strengthening industrial competitiveness," "establishing competitive environments," "disseminating R&D-derived benefits," "reducing energy and resource consumption," "protecting consumers," and "supporting the elderly and the disabled."

The importance of strategically acquiring international standards in recent years based on one's own domestic technology deserves special mention vis-à-vis bolstering international competitiveness, what with the development of new products intensifying the competition in capturing new global markets. Here, we must stress that losing out in international standardization despite having superior technology can interfere with market acquisition and stifle business expansion. To prevent these from happening, corporations must work strategically to acquire international standards from the beginning of the R&D stage and move forward with R&D and standardization in unison. Internationally, there is mounting need for standardization in social sectors such as public welfare, safety, and environment. Actively promoting international standardization in these areas as well is important.

1.2.3.3 Eliminating Trade Barriers

Standardization is also pursued for the purpose of protecting and expanding free trade. When standards between economies differ, they act as barriers to trade even as trade expands in terms of scope and amount. To liberalize and facilitate international trade, economies must try to unify and operate standards on a global scale (establish international standards). National safety standards between economies, for example, frequently differ depending on the economy's development level or method of implementing safety measures. Contrasting safety standards can lead to trade friction when they apply to products traded on a global scale. When international standards acceptable to all economies are established, and national standards in each economy are normalized with the international standards, however, the result will often be harmonized product safety requirements and more robust international trade.

The WTO Agreement on Technical Barriers to Trade (TBT) issued in 1995 has helped fulfill part of this role.

1.2.3.4 Stimulating Innovation

Most conversations on standardization's influence on innovation tend to focus on the market expansion effects when products hit the market. Note, however, that standardization continually stimulates innovation from the start of the R&D process to full market penetration. Chapter 7 deals with the relationship between standards and innovation in detail. Thus, in this section, we shall only give an overview.

At the start of a new research or a technical development project, consistent terminology and measurement units are needed so that researchers and engineers can communicate with each other. This is the very first standardization activity in the technology development process. Creating basic standards can be exactly described as laying down the groundwork to support R&D mobilization. As the R&D activity intensifies, sharing information on the results becomes important. To share information, however, there must be a way to compare results accurately. This is why testing standards are required at this stage. At the same time, the development and standardization of the measurement - which will be the base for the testing standards -- are obviously inevitable at an early point.

Once technical development has achieved a certain level of successful results, process standards standardizing manufacturing methods, quality management, and other processes are required before producing and rolling out products. Process standards substantially lower production costs associated with production equipment adoption and training of factory workers. Together with standardization aimed at lowering costs, standards that will stimulate and expand the market are needed. For instance, interface standards -- which are a part of product standards -- must be established to give new technologies access to existing markets; standards guaranteeing the new technology's safety (these, too, can be considered a type of product standard) are also required. In effect, these standards are essential if products based on the new technology were to supersede incumbent products. Testing standards are necessary at this stage to ensure the fair assessments of the new technology's functions and performance lacked by existing products.

As the market reaches a certain level of maturity, the relative abilities between suppliers of the new technology become apparent. If nothing but low-performance products or knock-offs fill the shelves, the market will collapse. To avoid this, standards are arranged many times, creating a class hierarchy of products based on testing standards. Examples include water resistance performance standards and energy efficiency standards for electronics products. Dividing products into classes to help differentiate products in the market expands the functions of testing standards, which are different from product standards.

With the progress of technical development, however, there are markets wherein all products surpass the highest standards, and there are many markets requiring minimum safety and quality baselines to be defined from the outset. In other words, product standardization in these cases allows products to reach the market without incurring massive investments in R&D in areas wherein further R&D is not warranted.

1.2.3.5 Regulations and Standardization

Relationship between laws and standards

A technical standard that is incorporated in a legal regulation or a law can be called mandatory standard. Technical regulation is the typical one. The WTO/TBT agreement defines "technical regulation" in Annex 1 as a "Document that lays down product characteristics or their related processes and production methods including the applicable administrative provisions compliance with which is mandatory. It may also include or deal exclusively with terminology, symbols, packaging, marking, or labeling requirements as they apply to a product, a process, or a production method." The objectives of most mandatory standards are to protect the public's health and safety by setting certain safety and environmental levels. Recently, more laws have been citing national standards and other voluntary standards. In these cases, even though the standard itself was drawn up as a voluntary standard, it becomes equivalent to a mandatory standard the moment it is cited in a law. The possibility of this kind of transformation in a standard's character is the most important part of the relationship between standards and laws.

Safety protection criteria should ideally be created based on scientific grounds, not by industry consensus. The problem is that this process frequently requires considerable time and data to assess risks accurately. In the meantime, however, consumers cannot be left unprotected due to delays in establishing safety standards. The most effective solution to this problem is to cite voluntary standards -- as shown above -- to begin protecting safety within the acceptable limits in the shortest timeframe possible. Engineers working with safety standards must always be aware of this fact.

Product standards and safety standards

When people think of safety standards in general, the first things that come to mind are standards for products such as helmets and child seats that ensure safety. Strictly speaking, though, these are not safety standards. Rather, these are part of quality standards guaranteeing that a product satisfies a given minimum level of quality. A true safety standard is that when safety can only be achieved through standardization or when standardization itself is what constitutes the safe outcome. Common examples include the opening and closing of a gas valve and the orientation of the gas cock or the positions of a toggle switch in an aircraft.

In between product standards and safety standards are numerous safety-related standards -- standards for the safe use of products, standards that are very important in their own right. Examples of these include standards to protect the safety of consumers and standards to protect the safety of workers in the workplace.

Standardization and safety standards for corporations

The strengthening relationship of safety standards and laws seems natural enough from the perspective of consumer protection. Still, what ramifications do safety standards hold for corporations?

The chief advantages of standardization for corporations are market expansion and lower costs. Nonetheless, safety standards, too, clearly have a pivotal role in market expansion. Safety standards push for improved product safety, giving purchasers greater confidence in the product and increasing its market size.

What corporations need to know is whether safety standards also play a role in reducing their costs. As we said before, absolute safety is unobtainable; therefore, safety protection is always a tradeoff between the elimination of risks and the costs incurred to eliminate them. If safety considerations are believed to outweigh the cost considerations, and corporations are required to work to eliminate all imaginable risks, however, the burden on corporations would be prohibitive. On the other hand, if safety standards exist, corporations can forecast the costs of eliminating the risks to the point of fulfilling the safety requirements and preventing additional spending on safety beyond this. In this context, safety standards can clearly slash corporations' costs.

There is one huge problem with this argument, however. If we believe that safety standards are criteria that manufacturers must comply with to protect consumers from harm, then surely these standards should be mandatory, not voluntary. Here is where the problem lies. If a safety standard is not mandatory, up to what degree does it protect safety? What motivation does the corporation have to comply with the standard?

If compliance with a standard is made compulsory, standard compliance will no longer differentiate products. On the other hand, if compliance with a standard is not compulsory, those who do comply with the standard will be able to differentiate their product at this point but will also be faced with higher production costs. The more rigorous the safety requirements in the standard are, the higher the production costs; moreover, there is a certain point of stringency at which corporations will be forced to drop out, and the value of having a voluntary standard will be lost.

As we have described above, the relationship between laws and what were voluntary safety standards has been shifting dramatically in light of mounting consumer protection concerns. Eventually, all safety standards may become mandatory, and no voluntary safety standards will be left. Recent problems involving amusement park rides have highlighted the danger when national safety standards exist, but these are not mandatory. Battery combustion is also an area where the government is looking at enforcing the present voluntary standards.

What we should be aiming for, though, is not safety dictated by laws but products that are inherently safe. A systematic series of safety codes can be immensely beneficial in assuring the inherent safety of products. Engineers engaged in developing and designing products should not be working to comply with safety laws but should develop and design products that are inherently safe instead by observing the systematic safety norms and codes.

1.2.3.6 Standardization and Environment

The previous section talked about the relationship between technical standards and laws primarily from the standpoint of safety issues. Technical standards are easily tied in to laws in the same manner when it comes to environmental issues. Europe in particular has commenced work on wide-ranging environmental regulations, and debate is ongoing on the technical standards that will form the basis of the regulations. Most observers expect the linkage between laws and dissemination of environmental standards to pick up speed on a global scale in the coming years.

After a short break from dealing with pollution problems that surfaced in various parts of the world, attention has turned to global environmental challenges such as ozone depletion due to chlorofluorocarbons and global warming caused by carbon dioxide. As definitive laws have taken shape, awareness of the social value of contributing to environmental sustainability has spread. Thus, the standardization of voluntary standards can be helpful in an increasing number of areas.

Environmental issues are the ideal issues for voluntary technical criteria, i.e., standards, to show their worth. Corporations, too, have taken action on the environment to pad their social contributions and polish their corporate image, and standardization is an increasingly important part of such. One example is the skyrocketing number of accreditations with ISO 14001, a standard for environmental management systems. Standardization bodies worldwide are not far behind, initiating the drafting of various environment-related standards.

Another movement that cannot be overlooked is the breadth of Europe's environment regulations. Some of the best known environmental regulations (EU directives) include REACH, which establishes new regulations on chemical substances, EuP, which requires home electronics, computers, and other energy-using products to use ecodesigns that lower the environmental costs throughout the product's entire lifecycle from raw material selection and manufacturing to transport, use, and disposal/reuse, RoHS, which restricts the use of certain hazardous materials in electronic and electrical equipment, and WEEE, which imposes on the respective manufacturers the responsibility for the collection and disposal of waste electrical and electronic equipment. These EU directives are driving the implementation of similar regulations worldwide. Since such regulations can act as non-tariff barriers to the expansion of world trade, however, there are moves to operate environmental regulations on the basis of uniform global criteria. In this area as well, standardization activities have a huge role to play.

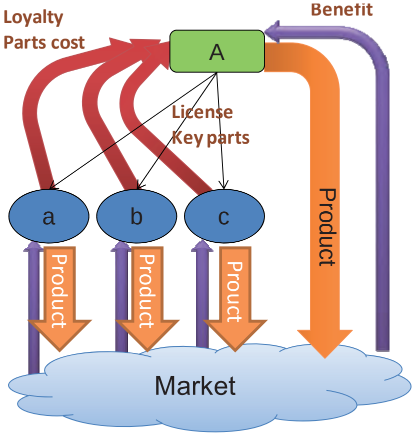
1.3 Classifications

1.3.1 De Facto, De Jure, and Forum Standards

The standards defined in Section 1.1.2.1 can probably be said to be the definitions of de jure standards; they fall under the international standards and national standards described in Section 1.3.3. In contrast, de facto standards and forum standards mainly refer to cases wherein the sites of creation of the standards are not "bodies with general recognition." Naturally, among the forums, there are bodies that are recognized worldwide; these may be referred to as "standards" even in the ISO standards. A similar term of consortium standards exists; given the current difficulty in differentiating between forums and consortia, however, the consortia shall not be differentiated here but shall be treated as forum standards.

1.3.1.1 Establishment of De Facto Standards

The de facto standards wielding great influence on corporate activities in the latter half of the 1980s were "standards" established through a process that is totally different from the definition of "standards" as explained in Section 1.1.2.1. "De facto standards" point to how -- as a result of the business activities of corporations -- the product of a certain corporation monopolized the market; since this product had a network externality, this led to a state wherein entering this market became impossible unless the interface used by such product was utilized. In other words, instead of the acquisition of a standard, such product technology became -- in a sense -- the standard since a specific product acquired the market. Therefore, this was a de facto standard.



◀Fig. 1-7
De Facto Standards

Accordingly, activities to establish a de facto standard are used as a strategy to capture a market share as the basic activity of corporations; in other words, they are activities that are used more or less to expand the sales of products by combining the capabilities possessed by corporations such as technology, marketing, sales, and advertising.

Note, however, that the establishment of de facto standards has significant meaning that cannot be found in market ownership only. Since there is a network externality, once market ownership has spread to a certain extent, it will progress rapidly as the effect of network externality; other technology products will then be driven out of the market. Moreover, given the great lock-in effect of such standards, the product can have long-term ownership. This is indeed one of the “effects of the standards”; even if they are “standards” that have been acquired, such merits will be immensely beneficial for corporations.

In addition, de facto standards differ from the standards established through the usual standardization activities in the sense that the developer is able to own the utilization of the standardized technology. As mentioned earlier, if they are consensus-type standards, then the utilization of the technology is generally made public, and a large number of companies are able to engage in the manufacture of the product. The ownership of a standardized technology is also a problem with regard to antitrust laws. If it is a de facto standard, however, then protecting such technology as intellectual property becomes possible under the patent law; thus enabling ownership as well. In other words, technology that has become a de facto standard will not easily be replaced by enhanced technology, and owning the market on a long-term basis becomes possible.

In contrast, the product technology that could not capture the market loses such, and the corresponding development cost becomes a sunk cost. As a result, a cutthroat de facto competition ensues in the market. The most well-known de facto competition was the battle between VHS and Betamax for the home videocassette recorder.

In the case of home videocassette recorders, since a network externality did not exist initially, the market was split, and both types increased their share. After the spread had progressed to some extent, however, the lending and borrowing of video cassettes began; this led to video rentals becoming a business, and the network externality of video cassette formats consequently emerged. As a result, the market as a whole leaned largely toward the VHS-format, which predominated the share. With markets possessing a network externality in this manner, a result wherein the winner finally ends up capturing the entire market often materializes, and both the return if the corporation wins and the risk if the corporation loses can be said to be huge.

1.3.1.2 From the Acquisition of De Facto Standards to Forum Standardization

As we have seen so far, the acquisition of a de facto standard is immensely beneficial for the corporation that developed the product. These days when technology is growing more complex and its development is accelerating, however, it is becoming impossible for a single company to develop the technology of one product. Moreover, given the rapidity of expansion after the market has started, expanding the market to a scale wherein the effect of the network externality can be seen before a competing product does likewise is of utmost importance from the business perspective. Therefore, among the products that the originator wishes to diffuse, there has been an increase in the number of cases wherein technology such as that of interfaces -- which wields great influence on network externality -- is made open and “the opening up of de facto standards” is carried out to encourage the entry of other companies. As a result, through an increase in the number of entrants, the effect of the network externality is intensified at an early stage, and the share of such product can be expected to be expanded rapidly.

As mentioned earlier, however, there is a need to take note of the possibility of an increase in the number of entrants possibly failing to translate into corporate profitability. If the technology is opened up to too widely by focusing on securing the market, such will lead to the subsequent entry of companies that do not need to take on the cost of development of such technology since they are able to capture the market share from the originating company through a low cost offensive. There are many cases wherein the developer expanded the market but lost profits by opening up the technology in such manner, a good example of which is the IBM PC and clone makers.

As long as it is difficult for one company to acquire a de facto standard, however, the spread of such trend is inevitable. Such paves the way for the increase in forum standards. In the IT field in particular, forum activities increased rapidly after 1995; after the year 2000, the increase in the number of forums peaked, whereas forums related to implementation specifications and connectivity (interfaces) forming the keystone of network externality have been increasing as before. In the same manner, the business model wherein "one company captures the market and emerges as the de facto standard" is generally changing to a business model wherein "the market is captured by spreading the standards through associates."

1.3.1.3 Fundamentals of Forum Standards

As seen above, forum standardization is gradually expanding as an offshoot strategy of de facto standards acquisition. As a result, forum standardization activities are deemed to form part of the de facto standard acquisition activities, and standards that have been created through forum standardization are largely referred to as de facto standards. Still, there is a need to recognize that de facto standards –which became standards "in effect" after the product captures the market -- and forum standards created by "consensus" through discussions held by an assembly of related persons for the purpose of expansion of the market have completely different characteristics. The biggest difference is the treatment of intellectual property of patents.

In the de facto standards, the intellectual property is owned by the single company that developed it. Such company can freely decide matters such as whether or not to allow its licensing and the licensing rate. Therefore, the company is able to monopolize the market by itself without any recourse to licensing. As a result, since de facto standard acquisition = market acquisition is inextricably linked to securing profit, the most important issue for the corporation will be how the de facto standard can be acquired.

With forum standards, however, this is usually carried out in accordance with the patent policy; ideally, the intellectual property included in such standards can be licensed to anyone at a reasonable price. In cases including a large number of patents, a patent pool may be formed; note, however, that the operation of a patent pool is subject to various restrictions of antitrust laws, and changing the licensing conditions depending on the other party is difficult. Even if it is an assembly of a number of companies for which a patent policy does not exist, such technology will have to be made open at a low price since consensus by multiple parties on licensing restrictions is a problem with regard to antitrust laws.

Therefore, the technology included in the forum standards cannot be monopolized by the standard creators or forum participants. On the contrary, with the acceptance of lowering of technology introduction barriers through the creation of standards, it becomes a technology that can be easily utilized by anyone. In other words, with regard to the technology included in these standards, the creation of forum standards will only have the standardization effect of reducing the market share of one's own company.

In the same manner, a forum standard, like the de jure standard, is a standard of the "consensus type." Its utility is also similar to a de jure standard. Compared to de jure standards, however, a forum standard has the advantage of enabling the creation of standards utilizing the latest technology within a short period of time and the disadvantage of low credibility with regard to the technology and poor maintenance of the standards, since the credibility of the organization has not been secured.

As shown above, the acquisition of de facto standards is not a standardization activity in the strictest sense of the word; rather, standard technology that has been acquired as a result has various effects as a standard. If a corporation is able to achieve this, then it will be able to obtain the most profits from the standpoint of business strategy.

In the present technology climate, however, it is becoming more difficult for a single company to acquire a de facto standard; standardization activities by forums are also commonly used as a tool for market acquisition. Note, however, that these forum standards differ from de facto standards since they cannot have ownership. This results in corporations opening up the market to other companies. As such, devising a business strategy by understanding this difference is becoming an important corporate activity.

1.3.1.4 Value of De Jure Standards for Corporations

At this point, let us look at the value of de jure standards in the eyes of corporations. It goes without saying that de jure standards are standards that were created following the procedures prescribed in the rules of international standardizing organizations such as ISO and national standardizing organizations such as ANSI or JISC.

The greatest value of de jure standards is their high credibility. These standards were created through talks between the participants of the entire market as the ones who actually use them; since the standards were adopted through the agreed upon rules, their technical completion rate is expected to be high, and they will most likely spread quickly as well. Furthermore, given the well-established maintenance system of the standards, the technology is guaranteed not to become obsolete but will regularly be modified to have high utility value. In addition, since the standards will normally have been cleared of matters related to patents and copyright issues, there will also be a sense of security regarding their use. Likewise, as explained earlier, if they are international standards such as those of ISO, they will be reflected on the national standards of each economy in accordance with the WTO/TBT agreements, and the market can be expected to develop globally.

Obviously, however, there are some failings even with the de jure standards. One representative example is that creation requires time. As the norm, the drafting of ISO standards requires a period of approximately three years; since revision also takes the same amount of time, they are not suited to standards for leading-edge technology. As the biggest problem with the de jure standards, however, the large number of participants in the creation of the standards rarely makes a standard draft drawn up by an individual a standard as is. There is also a possibility of the standards differing from the initial aim of becoming standardized owing to the many opinions being given during the revision. In other words, maintaining control over the standards draft becomes extremely difficult in the case of de jure standards.

1.3.1.5 Basic Concepts on the Utilization of Consensus Standards

As we have seen so far, both de jure standards and forum standards can be understood to be standardization activities wherein “standards are decided through talks.” Such standards are referred to as “consensus standards” (Shintaku and Eto, 2008). The biggest difference between such consensus standards and de facto standards as mentioned in the previous section is the value of the standard as intellectual property.

In de facto standards, intellectual property such as a patent -- which is included in such standards -- is owned by the company that acquired the de facto standard. As a result, the market that was acquired through de facto activities is owned through the use of the patent. Monopolizing the profit from such market also becomes possible. Precisely because of such, every company staking its future has taken part in the strong competition for de facto acquisition.

In the case of consensus standards, however, such standardized technology in general is based on the principle of allowing anyone free use or use at a moderate price. In other words, the technology has no value as intellectual property and offers no advantage to the company that developed it. Of course, even if it is a consensus standard, there are instances wherein the standard is created in the form inclusive of an onerous patent; in general, however, such patents are integrated to expand the market and should not be viewed as asset value (a more detailed explanation on this topic shall be given in Chapter 10).

Therefore, depending on their use, consensus standards can either become a source of profit generation for the corporation or the cause of profit loss. In carefully considering the pros and cons and combining consensus standardization activities and their surrounding patent and differentiation activities, it is important that the market expansion and cost-cutting effects of the consensus standards be maximized, and that a framework that increases profits be built.

1.3.2 International, Regional, National, Industry and Company Standards

In classifying the standards, the criterion for the scope of application of the standards may be used. From such viewpoint, standards can be classified into the following groups: “international standards,” “regional standards,” “national standards,” “industry standards,” and “company standards.”

1.3.2.1 International Standards

International standards are standards formed by international standardizing organizations such as ISO(International Organization for Standardization) Standards, ITU(International Telecommunication Union) Recommendations, Codex(Codex Alimentarius) Official Standards or OIE(The World Organisation for Animal Health) Code.

Furthermore, as requirements to be fulfilled in relation to the formulation process of international standards, the WTO/TBT (Technical Barriers to Trade) Committee agreed on the following six requirements:

Transparency (reporting and disclosure of draft proposals at the early stage of drafting the standards)

Openness (free participation by economies worldwide)

Fairness (decisions based on consensus)

Efficiency/Market suitability (ensuring that a specific market does not gain an advantage, adaptability to the regulatory system of each economy, emphasis on performance standards)

Consistency (avoidance of duplication)

Consideration for developing economies (necessary technical cooperation from standardizing organizations and developed economies)

1.3.2.2 Regional Standards

Regional standards are standards that are established by regional standardizing organizations whose representative examples are CEN (European Committee for Standardization), which prescribes the European Standards (EN) for many various fields aside from the electricity and transmissions field, CENELEC (European Committee for Electrotechnical Standardization) covering the European Standards in the electrical and electronics domain, and ETSI (European Telecommunications Standards Institute), which mainly prescribes the European Standards for the telecommunications, broadcasting, and information technology fields.

As an agreement on technical cooperation, CEN and ISO concluded the “Vienna Agreement” that combines or unifies as much as possible the ISO Standards and the European Standards and builds a mechanism for mutual interests by avoiding the duplication of work. Similarly, CENELEC and IEC have concluded the “Dresden Agreement” as an agreement on technical cooperation, with CENELEC embarking on a policy to implement as the European Standards the international standards prescribed by IEC (IEC Standards) without making any modification.

1.3.2.3. National Standards

National standards are standards prescribed by national standardizing organizations. In Japan, the Japan Industrial Standards (JIS) drafted by the national standardizing organization -- the Japanese Industrial Standards Committee (JISC) -- are an example. In Europe, the British Standards Institution (BSI) provides the British Standards (BS), and Deutsches Institut für Normung e.V. (DIN), the DIN Standards. The Association française de Normalisation (AFNOR) drafts some of the French national standards (NF Standards) as well as authorizes as NF Standards the standards drafted by certified French standardizing bodies. American National Standards Institute (ANSI) has designated American National Standards (ANS). In China, the Guóbiāo (GB Standards) have been given the highest priority among the national standards. On the subject of "technical demand requiring consistency on a national scale," the Standardization Administration of China (SAC) -- a national standardizing organization -- inspects, grants permission, specifies the numbering, and promulgates the standards. In other words, the establishment process and characteristics of national standards differ by economy.

1.3.2.4 Industry Standards

Industry standards are standards that are drafted by industry groups. For example, in Japan, the Japan Electronics and Information Technology Industries' Association (JEITA) drafts the JITA standards, and the Japan Iron and Steel Federation Standards Center, the Japan Iron and Steel Federation Standards. In the US, a large number of standard development organizations exist; the drafting of individual industry standards has been described earlier.

1.3.2.5 Company Standards

Company standards are standards provided for application in companies and factories to materials, parts, products, and organization or purchasing, manufacturing, inspection, and supervision works. Such in-house company standardization standardizes the technology of the company, unifying the work methods and reducing variability in the results by planning effective utilization through the accumulation of intrinsic technology and prescribing the work operation of the company; they are expected to have the effect of rationalization and improvement of work efficiency.

1.3.3 Basic, Testing, Product, and Process Standards

This classification regards as its foundation the characteristics of the standards. In ISO/IEC Guide 2, other than the standards given below, the standards for service standards, interface standards, and standards on data to be provided are also defined.

1.3.3.1 Basic Standards

Basic standards standardize terminology, symbols, and units. Among these, detailed standards including definitions and explanations of terminology are referred to as terminology standards and are sometimes organized separately.

1.3.3.2 Testing Standards

Testing standards standardize tests, analyses, inspections, and measurement methods. These standards solely prescribe the measurement methods. As with impermeability for example, however, in cases wherein measuring using a constant numerical value is difficult, inspection testing standards are sometimes created wherein various measurement conditions are established and judgments are made using a pass/fail system for each measurement. These standards possess the characteristics of both testing standards and product standards.

1.3.3.3 Product Standards

Product standards standardize the shape, size material, components, quality, performance, durability, safety and function of products.

Moreover, when a product is made in accordance with its appropriate product standard, whether or not the product that has been made conforms to those standards is of utmost importance in business transactions. The act of evaluating conformity to a standard is called conformity evaluation. In particular, the act of fair evaluation by a third party to check whether a product conforms to the appropriate product standard is referred to in the conformity evaluations as "(product) certification." The reason standards and certification are referred to as "the two wheels of a cart" can be found here. Note, however, that the person evaluating conformity to the product standard does not necessarily or inevitably have to be a third party; in fact, there are cases wherein the manufacturer itself evaluates conformity and makes a statement affirming its conformity (self-conformity declaration). Still, even in these cases, disclosing the necessary information proving the objectivity of the evaluation results is crucial. (Conformity evaluation shall be explained in detail in Chapter 3.)

1.3.3.4 Process Standards

Process standards standardize the process such as the manufacturing procedure of the product. In particular, standards that standardize quality control systems and management are referred to as management standards. From the perspective of having expanded from standards conventionally targeting "things" to the "organization" itself, management standards are the standards of a new domain. Management standards aim at the continuous improvement of the management of the organization. The model of PDCA -- Plan by forming a plan in accordance with the policy of the top management, Do by drafting and implementing an operation manual, Check by regularly using a check evaluation, and Act by review, which is known as the Deming cycle -- is used as a guide.

Representative management standards are ISO9001 (quality management systems – requirement items) and ISO14001 (environmental management systems – requirement items) characterized by a certification system wherein a third party evaluates whether the quality or the environment endeavors of an organization conform to the requirement items of the standards and publishes the results; this is known as ISO9000 or ISO14000 certification.

Questions & Discussions

1) Enumerate the pros and cons of standardization.
2) Explain the different features of de jure, de facto, and forum standards.
3) Discuss why standardization activities are important in facilitating international trade.

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Chapter 02

Lifecycle, Organizations, and Development Procedures

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Learning Objectives

After completing this chapter, you should be able to:

a) Understand the Lifecycle of standardization — not only lifecycle of single standard but also multi standards.
b) Know the various organizations that are related to standardization.
c) Learn the standard making process.

In this chapter, we shall first examine the lifecycle of standards from various perspectives to understand the basics of standardization activities. After enabling understanding of these processes, we shall explain the various bodies involved in standardization and the standardization procedures used by representative organizations.

Opening Case: Lifecycle of Keyboard Standards

The “QWERTY” keyboard layout is often used as an example when studying standardization. Paul David’s 1985 essay addressing the lock-in effect of the QWERTY keyboard is one of the major early works in the area of standardization research. The QWERTY keyboard is cited in standardization research because it can be used as a classic example of something that was not the optimal technological option but was able to survive for a long time once it became the standard and became popularized. Still, reports on this case were often said to contain many historical inaccuracies. Here, we shall look at the lifecycles of keyboard standards in the US and Japan based on the research of Mr. Yasuoka (Yasuoka and Yasuoka, 2008).

The first practical typewriter developed by American C. L. Sholes had only two rows of keys similar to a piano due to technical limitations. The alphabet was arranged in ABCD order starting from the top row. Note, however, that technical advancements eventually allowed for four rows of keys. The top (first) row was used for numbers, with the various letters moved to the bottom (fourth) row. The key arrangements varied depending on the period of typewriter development and the companies involved. There were even some companies that used different arrangements simply to avoid patent conflicts. The typewriter layout was finally unified by the Union Typewriter Company, which was founded in 1893. Using its patents, the Union Typewriter bought the five leading typewriter makers of that time and captured 90% of the typewriter market; thus virtually monopolizing it. Soon after its establishment, the company began standardizing the keyboard layouts of each acquired company. By around 1895, other companies were also using this same layout. The QWERTY keyboard layout became the market de facto standard.

To contest the QWERTY layout, Professor August Dvorak of Washington State University proposed in 1932 a new keyboard arrangement designed to be quicker since the keys used to type the most frequently occurring English words were made the most accessible. The US government even studied whether this new layout should be adopted. Nonetheless, it was never adopted since its advantages over the QWERTY layout could not be demonstrated. In 1966, the QWERTY keyboard was adopted as the US standard by ASA (currently known as ANSI). The Dvorak keyboard was also adopted as a standard by ANSI in 1983, and various promotion activities were developed. Currently, however, there is practically no recorded case of usage of the Dvorak keyboard.

The QWERTY layout was also adopted as the US standard computer keyboard layout in 1971 because “it is widely being used with typewriters.” At this time, however, two different standards for the layout of symbols were also recorded. In one case, the “symbol was placed on the number 2 key; in the other case, the @ mark was placed on the number 2 key. The latter option was the layout adopted by IBM, the Gulliver of the computer industry at that time. ISO was moving forward with keyboard standardization at that time, but the latter option was not adopted. Thus, an arrangement very similar to the former became the ISO standard. In the US, however, the IBM-type keyboard dominated the market, thanks to the influential IBM business.

In Japan, progress was made in standardizing keyboards using the Japanese kana syllabary, which differs from English typewriters (Yasuoka and Yasuoka, 2003). The kana keyboard arrangement used by Nippon Telegraph and Telephone Public Corporation (NTT) differed from the layout used by the Kana Character Association. In 1954, the National Institute of Advanced Industrial Science and Technology (AIST) began working on a Japanese Industrial Standard (JIS) for keyboards. These two keyboards were different because NTT selected its layout based on input efficiency after researching on the frequency by which the most common words arise; in contrast, the Kana Character Association sought an arrangement that would be easy to remember. Standardization of the kana character typewriter began with the adoption of a teletype arrangement as the JIS standard in 1961. Note, however, that the position of the numbers was different owing to the influence of the QWERTY keyboard; the kana arrangement was the NTT version. The arrangement for kana typewriters was determined in 1964. While the English alphabet keyboard arrangements at that time consisted of both the teletype version and the QWERTY layout, both the kana arrangements were based on the Kana Character Association version.

In 1972, numbers, English letters, and symbols were arranged in accordance with the ISO standard, and a JIS standard was created for Japanese language keyboards supporting the kana syllabary as well. The kana arrangement adopted at that time was the Kana Character Association version. This was because IBM -- which had a huge influence on Japanese computers at that time -- had adopted the Kana Character Association's version. As such, the situation mirrored that in the US. Even after this standard was issued, however, the previously established teletype version and the kana-type version coexisted for more than 20 years until they were abolished in 1994 and 1999, respectively.

Later, in 1986, the Electrotechnical Laboratory studied kana character input methods and proposed a new arrangement as a more efficient input method. That same year, JIS standards were established for such new keyboard arrangement for kana characters. With the government aggressively promoting the new arrangement, it had been adopted for 46 PC and word processor models made by 10 Japanese companies within a few years. Nonetheless, it still failed to capture the market. Finally, the arrangement was abolished in 1999 on grounds of poor utilization.

Looking at the history of keyboard standardization as described above, there are some striking similarities between the cases in the US and Japan. In particular, even when standards were scientifically proven to be more efficient and were actively promoted, they were not always adopted widely by the market. Depending on the standard, there can be great variations in lifecycles; standards development and differentiation can also proceed in various manners.

2.1 Lifecycle of Standards

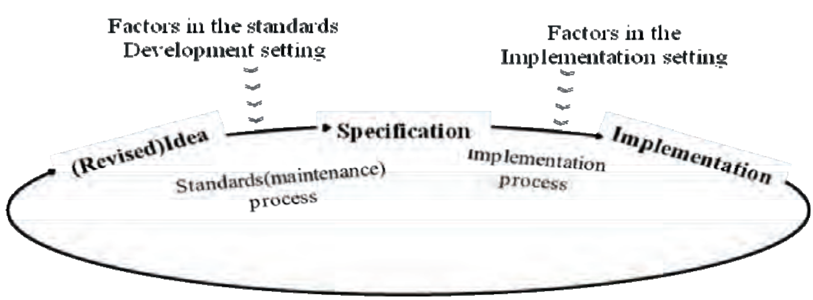
2.1.1 Lifecycle of Standards

Standards have lifecycles. The lifecycle of one standard consists of creation, adjustment, use, and abandonment (stoppage of use). If various derivative standards emerge from the original standard during this lifecycle, however, such standard itself will change and develop into a different standard. Understanding this lifecycle principle is essential in the utilization of standards.

2.1.2 Lifecycle Basics

The creation of standards except de facto standards begins when someone somewhere realizes the necessity for such standard. Achieving the desired effect will be difficult unless the standard becomes popular. Thus, a characteristic of standards is that they are created with the aim of being popularized from the start. Toward this end, the creator needs to determine how to align best the purpose and effect of the standard. A forum with only a small number of participants can be effective when one wishes to establish and promote a standard quickly. National standards will be required when domestic authority is needed. Standardization by an international standardizing organization such as ISO will likely be needed when the standard impacts international trade. ISO has established a time limit for the standardization process (see Section 2.3). Specifically, a final vote must be reached within five years of the start of standardization activities. After a standard is published, activities for promoting such standard are very important. The popularization of forum standards is fast because these standards are created by those wishing to use the standards. In the case of national and international standards, however, the desire to use the standards can vary widely among those participating in the creation process; hence the need for various activities to promote the standards.

Fig. 2-1► Schematic representation of the phases leading to standard implementation (Egyedi 2008)



The establishment of conformity assessment systems can play a major role in the promotion of standards. In the cases of ISO9001, etc., the popularization of conformity assessment systems undoubtedly helped drive the promotion of various standards. Such cases are not limited to management systems only. In product verification fields as well, there are many cases wherein conformity assessment systems played major roles in promoting standards. Germany's DIN mark, Japan's

JIS mark, and other voluntary certification systems have played major roles in promoting standards. Note, however, that the effectiveness in promoting standards is magnified when the certification system is backed by related laws and regulations. Examples include electrical safety marks such as the CE mark in Europe and China's CCC mark. Conformity assessment systems will be explained in more detail in Chapter 3.

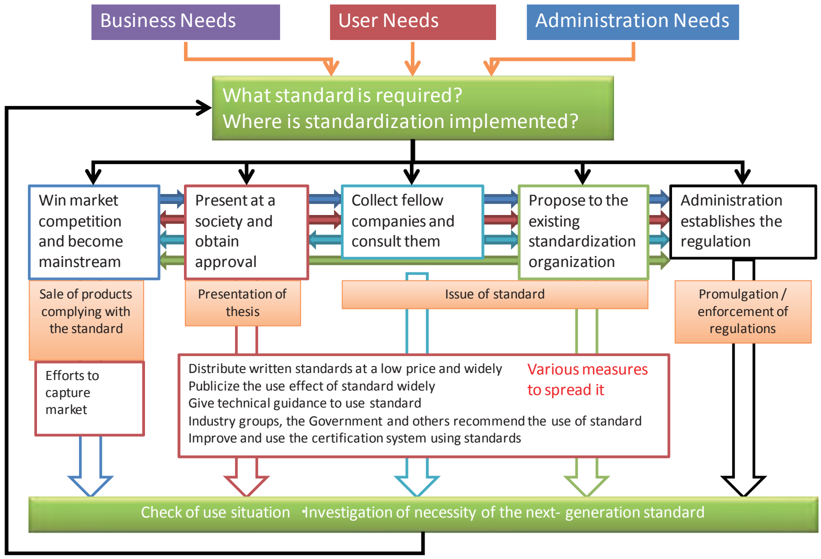
When planning the promotion of a standard, its maintenance is another important consideration. Once standards are actually put to use in the markets, problems and areas for improvement are often uncovered. Furthermore, in the course of advancement of technologies, the existing standards can deter product performance. The extent to which standards can impede technological advances will be discussed in more detail in Chapter 7. The important point to remember is that standards need to be revised regularly to minimize such harmful effects. ISO and IEC have implemented a rule, i.e., standards must be reviewed every 5 years, arguing that revisions are necessary if the standards are to remain in step with the technological advances and societal changes.

Even when such regular revisions continue to be made, however, there will come a time when the use of a particular standard becomes difficult. In many cases, no particular operations are required since the number of people using the standards decline and the standards cease to be used. No doubt, the existence of some old standards can hamper technological advances and distort the simplification of technologies. A report issued by England's BSI and DTI in 2005 (DTI, 2005) quantitatively studied the economic impact of standards. According to the report, as standards get older, they wield a negative impact on economic growth. It also cited the importance of aggressively abolishing those standards with a reduced number of users. Naturally, the abolishment of the old standard should be preceded by the establishment of a new standard that is in step with the new and different technologies and social environment.

An interesting case related to the lifecycle of specifications as described above is the "Provisional Japanese Engineering Standards" established by the Japanese government during World War II.

Since Japan is not rich in natural resources, it depends largely on imports for the supply of natural resources such as iron and rubber. With trading ceasing during World War II and importing these natural resources becoming difficult, effectively utilizing the existing resources in Japan was politically important. Thus, Temporary JESs were established to address this problem. These standards were the "lowest-quality standards" that specified the requirements for manufacturing products supporting the least necessary functions while minimizing the consumption of resources. It was politically recommended for various products that these Temporary JESs be established so that products would be produced using these standards by applying them as governmental procurement standard and giving preferences to distributing resources to manufacturers adopting the standards during World War II. By the end of the war, the adoption of these standards had nearly the same significance as a regulation for product manufacturers; in fact, many of the domestic industrial products were produced in compliance with these Temporary JESs.

Fig. 2-2 ▶
Lifecycle of standard



When the war ended, and the import of resources resumed, however, the existence value of these Temporary JESs – which were contrived to minimize the use of resources -- depreciated. Moreover, they were viewed as a barrier to exports if the export of Japanese industrial products was attempted. Therefore, all of these Temporary JESs were discontinued several years after the war to reestablish industrial standards so that high-quality products suitable for export could be produced. This was how the JIS standards, which are now the national standards in Japan, were established. In many cases, product standards are rarely discontinued once they are issued, but they may be revised in keeping with the technological advancements. Still, this case indicates that they should be discontinued actively if they do not match the social circumstances of the time and if their existence is deemed to hinder development.

2.1.3 Growth of Standards

So far, we have studied the lifecycle of standards by focusing on certain standards. Nonetheless, considering the lifecycle of standards is crucial to understanding that they consist of multiple standard elements each of which could serve as a standard, and that they are established in order. This is called the growth of standards herein.

For example, a product standard for “pencils” describes not only the shape of the pencil and the type of hardness of the lead but also the methods of testing the lead hardness and its toxicity. As a matter of course, terms unique to pencils such as black lead and hardness degree are also defined. There are also many cited standards as standards necessary for utilizing the product standard for pencils. In other words, the product standard for “pencils” is established through the accumulation of many other standards from the past, and the standard itself is a combination of the “basic standard” including terms and so forth, the “test method standard” for product testing, and the “product standard” for product specifications. Of course, we should keep in mind that the existence of this standard is supported by "measurement."

Considering the relationship between standards and innovation, however, the growth of standards themselves is an important lifecycle. England's Swan looked at this standards/innovation relationship based on individual standards (Swann, 2000). Nonetheless, a greater standards/innovation effect can be seen when the growth of standards themselves is considered. This will be tackled in Section 1.2.3.4 and explained in more detail in Chapter 7. Suffice it to say, basic standards, testing standards, product standards, and process standards all grow along with innovation in the following manner:

First, "basic standards" such as terminology and units are created. In many cases, such standardization is initially part of the relevant field, and the terminology used by those announcing the results at academic societies and other settings are naturally adopted as the standards. Such de facto standards are born in these academic societies, not in the markets. When similar technologies are created at the same time but in different research fields, however, the same technologies and phenomena are likely to be given different names. With the systems involved becoming bigger and more complex, achieving standardization becomes harder unless the trends are recognized and uniform terminology is established at an early stage. A classic example is environmental technology. Various industries are simultaneously developing these technologies, creating disorder in terms of terminology and utilization methods; thus causing immense difficulty for ISO in attempting to unify the terminology. Nonetheless, there will likely be a natural unification of terminology even if no steps are taken. In these times of complicated, quickly evolving technologies, however, intentionally driving the standardization efforts is essential.

In many cases, the testing standards created during the research & development stage are authorized by academic societies and similar groups. When testing standards are standardized, various results developed by different researchers can be compared using common methods. Moreover, through the exchange of information, the merits of the technologies can be assessed; this can lead to the next step in the technology development process. As such, the created testing standards help in a way in terms of stimulating the work of researchers by encouraging them to develop technologies that will be favorably assessed.

Process standards, interface standards, and new technology testing standards are needed for the next stage. For example, in the commercialization of photo-catalysts, testing standards were established at the research & development stage so that products with strong anti-bacteria function could be compared with the silver products and other anti-bacteria products. Nonetheless, methods of assessing the "self-cleaning function" provided only by photo-catalysts were not standardized; thus, this function could not be assessed by the markets. As a result, approaches to standardizing testing methods for self-cleaning were taken after the product was marketed. Today, international standards are being applied. These standards can serve as a driving force in opening up new markets.

When markets reach a certain degree of maturity, standards can be made by dividing the numerical values of the generated testing standards into classes.

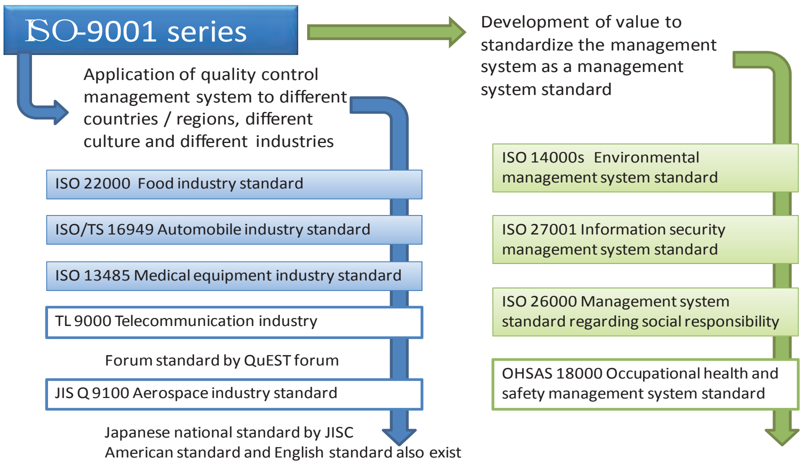
Examples of such standards include those covering waterproofing for electronics and energy-saving standards. Such labeling by class is different from product standards since it supports the differentiation of products in the market. It maintains testing standard functions, with the testing standards considered the first stage in developing product standards. In fact, the continuity between basic standards, testing standards, and product standards should ideally be recognized. In many cases, terminology and units are defined within the testing standards and product standards. For all product standards, the testing methods for realizing the actual product must be established. Note, however, that this does not apply to testing methods such as those for measuring length and weight, which are already standardized. Thus, such well-known testing methods do not need to be included in the standards.

Therefore, as technological development progresses, the assessments of the results of testing standards are incorporated back into the standards. In other words, testing standards evolve into product standards as the market expands. The role of the standard in technical development can change drastically depending on whether or not the testing standard includes a single requirement for the product (not divided into steps). At the step wherein there is no product requirement, the testing method can help spur technology development with the aim of achieving good results. Once there is a single requirement, however, any research & development other than that aimed at satisfying this numerical target will not have much market appeal; thus essentially snuffing out research & development. At first glance, this appears to hamper research & development; considering the overall innovation, however, such is actually the appropriate action. Research of any theme will eventually reach a limit wherein the values of the testing method cannot be raised further. If the value in raising the obtained numbers becomes smaller than the research & development costs, such particular research can be ended, and costs, transferred to other more promising research. In other words, product standardization can be equated with the halting of technical development in that field (the actually developed technologies are introduced to the market).

2.1.4 Derivation of Standards

Along with the growth of standards, the derivation of standards is another important point in the lifecycle of standards. The derivation of standards involves the establishment of additional standards in other fields when the application range for a particular standard changes. An easy-to-understand example is the ISO9001 quality management standard. This original standard has been developed for various industries such as the ISO/TS 16949 automobile industry standard, ISO 22000 food industry standard, ISO 13485 medical equipment industry standard, and TL 9000 telecommunications industry standard. In particular, the ISO14000 environmental standards and ISO27000 information security standards have been developed as “management standards” approaches.

Similarly, various “children” can be born from one parent standard; the development of each as independent standards is often seen in the world of standardization.



◀Fig. 2-3 Derivation of Standards

2.2 Standards-Related Organizations

2.2.1 SDOs/SSOs

SDO stands for Standard Development Organization; it is a word that includes organizations that continuously implement standardization in a broad sense. There are many SDO(s) at the international level, state level, and industrial level in the world. The most famous international standardization organization, especially for Asian economies, may be ISO which developed ISO-9000 family. Codex Alimentarius Commission (CAC) established by FAO and WHO is also famous in food industry. By WTO/SPS agreement relations, there are similar organizations, such as OIE which determines the international safety standards of livestock. OIML is one of the **two** peak international measurement bodies; the other is the BIPM/CIPM. Thus, there are many organizations dedicated to developing international standards. In addition, as Chapter 1 described, we must be cautious of the TBT agreement not specifying the "international standardization organization."

Various standards are also created in the organization whose standardization activity is not a main purpose such as "Recommendations on the Transport of Dangerous Goods" developed by United Nations. In this case, we may say, "UN has SDO functions."Although the organizations that establish the national standards for each economy are also SDOs, they are called National Standards Bodies (NSBs) in general. National standardization organizations in western economies including the US (ANSI), United Kingdom (BSI), France (AFNOR), and Germany (DIN) are private organizations, and they are tasked with the development of national standards for government ordinances or contracts. In contrast, government organizations directly develop the standards in many other economies, and their business models vary widely.

These NSBs depend on domestic private organizations for the development of standards in many cases. Note, however, that the creation of standards is not the main function of these organizations; in many cases, part of the functions of industry bodies are to create standards. Such organizations may also be called SDOs; generally, however, the term SDO is used for those organizations whose main functions include standards creation.

Table 2-1 ▶ Standards-Related Organizations example

	ISO	IEC	ITU-T/ITU-R	OIML
	International Organization for Standardization	International Electrotechnical Commission	International Telecommunication Union Telecommunication Standardization Sector/ Radiocommunications Sector	International Organization for Legal Metrology
Organizational generalization	International standardization organization for all fields except electricity and telecommunication (14941 standards)	International standardization organization for electric technology (4840 standards)	International standardization organization for telecommunication	Organization that solves administrative and technical problems caused by use of measuring apparatus
Establishment	1946(ISA:1928)	1906	1932(CCITT:1865)	1955
Number of members	February,2005 147 Full member 100 Associate member 47	February,2005 65 Full member 51 Associate member 14	Member nation 189 Corporate member More than 650	November, 2003 109 Member nation 60 Associate member nation 49

SDOs include private-sector forums that continuously develop standards such as ECMA International. Note, however, that these organizations are often called Standard Setting Organizations (SSO) when they create standards only for a specific product field. In the IT field in particular, SSOs are formed for each product technology, and they create various standards. For example, DVD forums and W3C are very common among SSOs, and they are similar to SDOs; in the IT field alone, however, several hundred SSOs are said to be active. These activities are often called forums and consortium; note, however, that the creation of standards is not the main goal of the forum or consortium in many cases.

Along with international standardizing organizations such as ISO, IEC, and ITU are regional standardizing organizations such as CEN, CENELEC, and ETSI in Europe. These organizations exist in other regions as well, such as the Pan-American Standards Commission (COPANT) in the Americas, Pacific Area Standards Congress (PASC), African Organization for Standardization (ARSO), and Arabic Industrial Development and Mining Organization. Unlike CEN and CENELEC, however, organizations such as PASC do not create independent standards. Thus, they cannot be called SDOs.

Some of the standardizing organizations in smaller regions include the Mercosur Association of Standardization (AMN), CARICOM Regional Organization for Standards and Quality (CROSQ), and ASEAN Consultative Committee on Standards & Quality (ACCSQ).

2.2.2 Conformity-Related Organizations

In principle, creating standards and conducting conformity assessments that use standards are unrelated and are usually performed by completely different organizations. In each economy, however, there are sometimes cases wherein both roles are performed by a standardizing organization representing the economy.

The three conformity assessment systems handled by certification bodies are management system certification, product certification and personnel certification.

The requirements for certification bodies are prescribed in ISO/IEC17021, ISO/IEC Guide 65 (currently being revised) and ISO/IEC 17024. There are various types of certification bodies from those that are pure private sector corporations to non-profit corporations and government entities, but they all have organizations for providing the certification bodies' accreditation.

Other important conformity assessment activities include those carried out by testing and calibration laboratories and inspection bodies. Requirements for testing and calibration laboratories are described in ISO/IEC17025, and those for inspection bodies, in ISO/IEC17020.

All these types of conformity assessment bodies can seek accreditation by an accreditation body for the services they offer. To elaborate on the definition of "accreditation" as provided in the first chapter of this textbook, an accreditation certificate is a testament to the competence of a conformity assessment body (CAB) to perform a specific function or task related to conformity assessment activities.

The accreditation bodies that accredit CABs aim at providing a very high level of public service. This role is usually not fulfilled by private-sector corporations; instead, depending on the economy, such is played by non-profit organizations either created by the government or designated by the government for their accreditation activities. As an affiliation of accreditation bodies providing accreditation services for certification bodies, the IAF (International Accreditation Forum, Inc.) was launched in 1993 as a result of the first meeting of "Organizations Accrediting Quality System Registrars and Certification programs" based in 6 different economies (USA, Mexico, Netherlands, UK, Australia/New Zealand, Canada, and Japan). During the 12th IAF General Meeting held in Australia's Gold Coast on October 29, 1998, IAF was registered as a non-profit corporation in the US state of Delaware as an impartial organization separate from any government The IAF secretariat is currently based in Australia with approximately 70 accreditation bodies as members. In the APEC region is the Pacific Accreditation Cooperation (PAC), which has a similar function to that of IAF at the global level in the region. As an organization of accreditation bodies in the APEC region accrediting certification bodies, PAC was established in 1995 based on an Australia proposal.

ILAC, like IAF, is a global organization. It is a cooperation of accreditation bodies that accredit laboratories and inspection bodies. ILAC was established in 1977 as the International Laboratory Accreditation Conference to serve as an international forum for the accreditation bodies of laboratories and inspection bodies as well as related interested organizations. In 1997, it was re-launched as the International Laboratory Accreditation Cooperation, an international organization whose membership was drawn from accreditation bodies and related stakeholder organizations. The Asia-Pacific Laboratory Accreditation Cooperation (APLAC) was established in 1992 as a cooperation of accreditation bodies in the APEC region responsible for the accreditation of laboratories and inspection bodies.

In Europe, most economies have a single accreditation body dealing with all forms of accreditation. IAF and ILAC work cooperatively together on matters of mutual interest; they have established a Joint Executive Committee to facilitate such closer cooperation.

There is a combination of systems for authorizing organizations researching on personnel training and systems for authorizing personnel training courses due to the transition period accompanying the issuance of ISO/IEC 17024 in 2005. In the future, however, these systems will be merged into course certification. This will be explained in more detail in Chapter 3.

2.2.3 Organizations related to measurement

International measurement activities are coordinated under two intergovernmental treaties, the Metre Convention covering scientific and industrial measurements (1875), and the Convention Establishing an International Organization of Legal Metrology (the OIML Convention) for legal metrology (1955).

Under the Metre Convention, the peak expert scientific body is the International Committee for Weights and Measures (CIPM) which oversees the activities of the International Bureau of Weights and Measures (BIPM), the central coordinating laboratory, and is advised by ten expert Consultative Committees covering each area of metrology (see www.bipm.org). In 1999, the CIPM established the Mutual Recognition Arrangement (MRA) for national measurement standards and for calibration and measurement certificates issued by National Metrology Institutes (NMIs).

The OIML is the international legal metrology organization to “promote global harmonization of legal metrology procedures” relating to the “manufacture and use of measuring instruments for legal metrology applications”. Activities of OIML include: (1) development and issuance of international recommendations (R) and international documents (D); (2) management of the OIML certification system, and; (3) management of the OIML Mutual Acceptance Arrangement (MAA).

In the Asia Pacific, the two counterpart regional bodies are the Asia-Pacific Metrology Programme (APMP) for scientific and industrial measurement activities and the Asia Pacific Legal Metrology Forum (APLMF).

2.2.4 Organizations Representing Users/Consumers

Looking at the other organizations involved in standardization, the role of organizations representing standards users and consumers has been growing recently. Some typical organizations include the International Federation of Standards Users (IFAN) and ANEC (the European consumer voice in standardization). Many economies include Japan have been promoting greater participation by consumers in the creation of standards. Currently, however, there are few user and consumer groups that are very influential in the creation of standards; in fact, the interests of corporations and users are often at odds in the creation of standards. This will be a major issue in the future development of standards creation systems.

2.2.5 Other organizations related to standardization

While we have discussed various organizations related to standardization so far, we must not forget about the corporations and research institutes when considering standardization activities. Many standards trace their roots to corporations or research institutes. These are not only the de facto standards but also forum standards and de jure standards whose drafts are in many cases prepared by certain organizations. Corporations are in direst need of standardization as users that actually use the standards.

Research institutes particularly public research institutes also play an important role in the development of standards. Public research institutes have many roles to play in determining various terms and test method standards, not to mention the management of legal measurement. In today's society where the recent standardization activities by consensus are becoming increasingly active in particular, the coordinating role of public research institutes cannot be ignored. Although universities may be capable of playing the role as well, the current situation unfortunately depends on the voluntary activities of specific individual researchers in many economies regarding the roles of universities.

2.3 Standards Development Procedures Example

2.3.1 ISO Procedures

ISO develops standards to meet the needs of each field. New Work Item Proposals (NWIPs) are submitted to ISO. Once approved, the proposal is assigned to the appropriate Technical Committee (TC) based on its characteristics. The standard proposed as NWIP is discussed within the TC in accordance with the process for establishing standards. As of the end of 2006, some 3,041 technical items were being discussed by 193 TCs. ISO standards are mostly developed by TCs, which are entrusted with the work of deliberating on the draft standards and are made up of specialists in the related industrial, technical, and commercial fields that are likely to use the standards. In many cases, these specialists have close ties with ISO member government organizations and research organizations, consumer groups, non-government organizations, academic societies, and other groups.

ISO standards are created based on consensus among ISO member organizations. Deliberation is carried out by TCs and sub-committees (SCs) based on the following six stages:

Stage 1: Proposal Stage
Stage 2: Preparatory Stage
Stage 3: Committee Stage
Stage 4: Inquiry Stage
Stage 5: Approval Stage
Stage 6: Publication Stage

If a document with a certain degree of maturity is available at the start of a standardization project, e.g., a standard developed by another organization, certain stages may be skipped. Based on this so-called “fast-tracked procedure,” a document is submitted directly for approval as a Draft International Standard (DIS) to the ISO member bodies (stage 4) or as a Final Draft International Standard (FDIS, stage 5) without passing through the previous stages if the document has been developed by an international standardizing body recognized by the ISO Council.

Stage 1: Proposal Stage

The first step in the development of an ISO Standard is to confirm that a particular International Standard is needed. A new work item proposal (NP) is submitted to the relevant TC or SC to determine the inclusion of the work item in the program of work. The proposal is accepted if majority of the P members of the TC/SC vote in favor and if at least five P members declare their commitment to participate actively in the project.

Stage 2: Preparatory Stage

Usually, a working group of experts whose chairman (or convener) is the project leader of the standard development is set up by the TC/SC for the preparation of a working draft. Successive working drafts may be considered until the working group is satisfied that it has developed the best technical solution to the problem being addressed. At this stage, the draft standard is forwarded to the working group’s parent committee for the consensus-building phase.

Stage 3: Committee Stage

As soon as a first committee draft is available, it is registered by the ISO Central Secretariat. It is distributed for comments -- and if necessary, voting -- by the P members of the TC/SC. Successive committee drafts may be considered until a consensus is reached on the technical content, in which case the text is finalized for submission as a Draft International Standard (DIS).

Stage 4: Inquiry Stage

The Draft International Standard (DIS) is circulated to all ISO member bodies by the ISO Central Secretariat for voting and comments within a period of five months;

it is approved for submission as a Final Draft International Standard (FDIS) if two-thirds or majority of the P members of the TC/SC are in favor and not more than one-quarter of the total number of votes cast are negative. If the approval criteria are not met, the draft standard is returned to the originating TC/SC for further study, and a revised document will again be circulated for voting and comment as a Draft International Standard.

Stage 5: Approval Stage

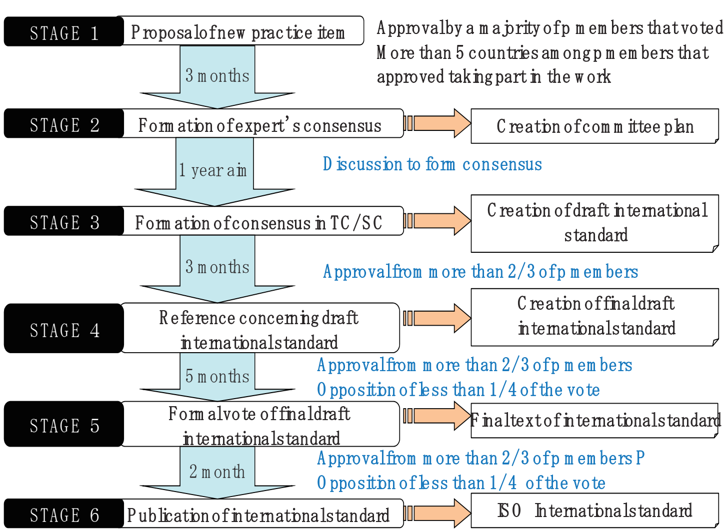
The Final Draft International Standard (FDIS) is circulated to all ISO member bodies by the ISO Central Secretariat for a final Yes/No vote within a period of two months. If a national body votes affirmatively, it shall not submit comments. Technical reasons for negative votes are submitted to the technical committee or subcommittee secretariat for consideration at the time of next review of the standard. The text is approved as an ISO standard if two-thirds or majority of the P members of the TC/SC are in favor and not more than one-quarter of the total number of votes cast are negative. If these approval criteria are not met, the standard is referred back to the originating TC/SC for reconsideration in light of the technical reasons submitted for the negative votes received.

Stage 6: Publication Stage

Once a Final Draft International Standard has been approved, only minor editorial changes -- if and where necessary -- are introduced into the final text, which is then sent to the ISO Central Secretariat for publishing as ISO standard.

Review of ISO standards (confirmation, revision, withdrawal)

All ISO standards are reviewed at least five years (proposed change to three years under deliberations) after publication and every five years following the first review by all ISO member bodies. A majority of the P members of the TC/SC decide whether an ISO standard should be confirmed, revised, or withdrawn.



◄TFig 2-4 Standard development procedure in ISO

2.3.2 ITU Procedures

ITU develops standards to address various problems; these standards are published as “ITU Recommendation.” ITU-R’s Radio Communication Assembly assigns problems to the appropriate radio communication study groups (SGs). These problems are discussed in the SG in accordance with the process for establishing standards. Draft standards that obtain a conclusion from the SG are reported to the Radio Communication Assembly; the assembly then issues approval and makes a recommendation, and the standard is established.

With ITU-T, the member economies, relevant parties, and study groups can raise problems to the Telecommunications Standardization Study Group. Draft standards that obtain a conclusion from the SG and the approval of the member economies become standards offered as recommendations.

Currently, ITU-R has six SGs, whereas ITU-T has 13 SGs. Likewise, ITU-R has XX standards, with ITU-T having more than 3,000.

ITU-T deliberations on standards are broken down into the following three main stages:

Stage 1: Proposal Stage
Stage 2: Approval Stage
Stage 3: Publication Stage

Stage 1: Proposal Stage

The first stage in the development of an international standard is to confirm the necessity of the draft standard. Issues are submitted to the appropriate committees, with the World Telecommunication Standardization Assembly or committees making a decision regarding the development of the standard.

Stage 2: Approval Stage

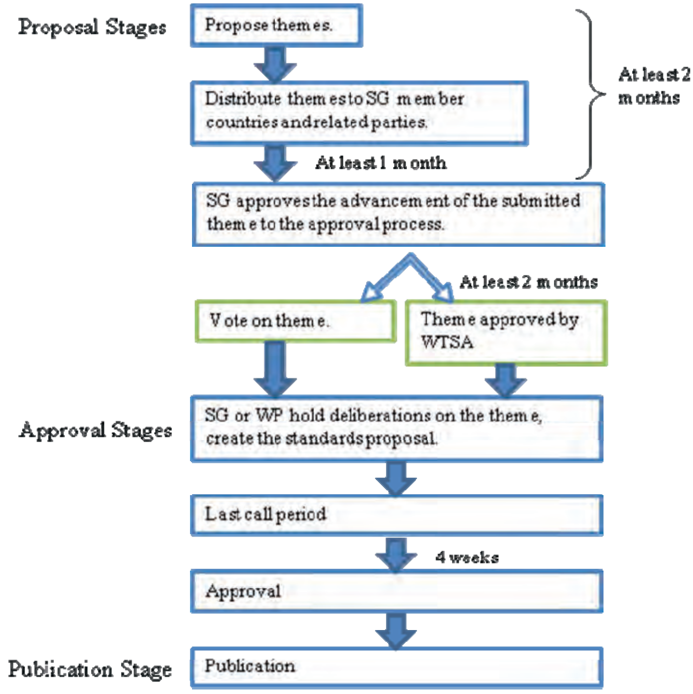
After a decision to develop the standard is made, either AAP (Alternative Approval Process) or TAP (Traditional Approval Process) will be selected as the development approval process. AAP is selected for normal standards development, and TAP, for the development of standards involving the government and regulations.

With AAP, once the SG or WP (Working Party) reaches a consensus on the draft standard, the Telecommunication Standardization Bureau chief issues a last call period notice as the start of a period of less than four weeks of submitting opinions. If no opinions are submitted during this period, the draft standard will be recognized as an ITU standard. If opinions are submitted during this period, however, the SG will again vote on the draft standard after amendments have been made by taking the opinions into account. If approval is subsequently granted, the standard will be recognized as an ITU standard.

With TAP, once the SG or WP (Working Party) reach a consensus on the draft standard, the Telecommunication Standardization Bureau chief will call for the start of a final vote lasting at least three months. The draft standard will be recognized as an international standard if at least 70% of the votes are in the affirmative.

Stage 3: Publication Stage

Once final recognition as international standard is secured, the standard will be published by the Telecommunication Standardization Bureau.



◀Fig 2-5 Standard development procedure in ITU-T

2.3.3 Other International Organizations

Other standardizing organizations have their own standards establishment processes, but the conditions required for creating standards and the relevant periods vary. For example, ECMA International holds a general assembly once a year to vote on standards. As such, standards are developed following this assembly, and many standards are established within one year of their proposal. The same general assembly method is also used by the International Civil Aviation Organization (ICAO), but its assembly is held only once every three years. Thus, very careful preparations are needed focusing on this meeting, which only comes once every three years.

The creation of standards involves coordination with various organizations, development based on procedures, and promotion. Therefore, fully understanding the characteristics of the desired standard and subsequently selecting a standards-creating organization are important standardization activities.

Questions & Discussions

1) Typical SDOs (ISO, IEC, ITU, ECMA, ASTM, CEN, CENELEC, ETSI)
2) Discuss the differences in the standards development processes.
3) Discuss the differences in the lifecycles of standards.

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Chapter 03

Conformity Assessment

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Learning Objectives

After completing this chapter, you should be able to:

a) Understand the purposes of conformity assessment and its related key definitions.
b) Recognize the conformity assessment classification and its main activities.
c) Master the major management system certifications and their main characteristics.
e) Master the major product certifications and their main characteristics.
d) Gain basic knowledge of MRAs and its role in international trade.

Opening Case: Enterprises that Benefitted from ISO 9000 Certification in China

China has many small and medium-sized enterprises that used to lack quality management methods. Through quality management system certification, however, most of them have improved their quality management and assured their product quality; hence their improved market competitiveness and the greater economic benefits they enjoy. The following are the results of a sampling survey among 142 registered companies that obtained ISO 9001 certificates 3 years ago:

- Product quality improved

Companies that implemented the 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 4.7% since the implementation of the ISO 9001 standard.

- Economic benefits increased

Quality management system certification translates into a reduced number of defects and quality failures; this in turn leads to reduced product costs. An appropriate management structure is established, and the company enjoys greater economic benefits. Accordingly, the survey revealed that 74.0% of the respondents realized a reduction in costs related to quality.

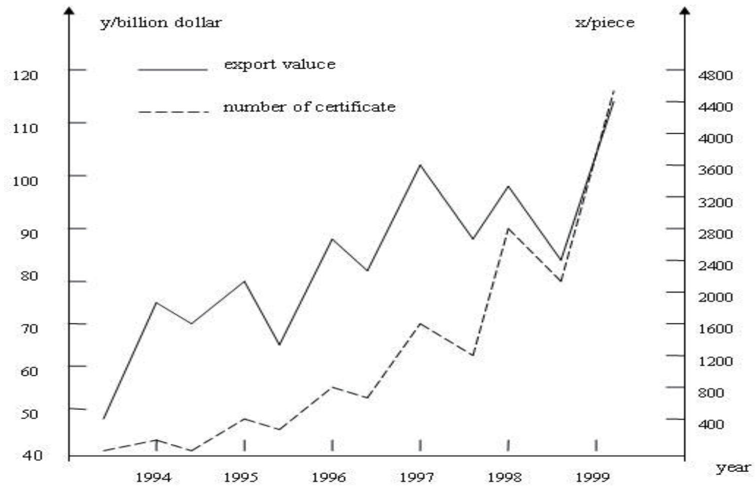
- Management level enhanced

Thanks to the implementation of the quality management system certification, the quality awareness of managers and employees increased. Internal audits and management reviews enhanced the company’s ability to identify and rectify problems and to maintain an efficient operational quality system.

According to the survey, 93.7% of the respondents witnessed a marked improvement in quality awareness throughout the process of quality management system certification; at least 96.5% of the respondents improved the work quality of their personnel.

- Competitiveness strengthened

The objective of every company in China is to gain a larger market share particularly to enjoy greater success in the international market with the ISO 9001 quality management system certification. Many companies in China regard the ISO 9001 certificate as a “ticket” to the export market. With ISO certification, 64% of the companies recorded growth in terms of their domestic market share and enjoyed 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 number of certified companies in China shows a significant positive correlation, suggesting that the ISO 9001 quality management system certification plays an important role in increasing the export volumes of Chinese companies (Song, 2001).



◄Fig. 3-1 Relationship between the Number of ISO 9000 Certificates and Export Volumes in China (source: Song, 2001)

3.1 Overview of Conformity Assessment

Explaining conformity assessment without regarding it as part of a major system and two relevant organizations -- the International Standardization Organization (ISO) and the International Electrotechnical Commission (IEC) – is difficult. Delving into the importance of conformity assessment requires identifying the key role that these entities play. ISO is the world’s largest developer and publisher of International Standards, whereas IEC prepares and publishes International Standards for all electrical, electronic, and related technologies as the world’s leading organization.

Confidence comes from knowing that the requirements are met. Standards stipulate state-of-the-art requirements. ISO and IEC standards and guides related to conformity assessment define the processes and good practice for checking that the requirements are met. ISO and IEC jointly develop standards and guides for all conformity assessment activities.

ISO promotes the international harmonization of conformity assessment activities and worldwide acceptance of the results through ISO/CASCO as its general policy committee on conformity assessment. ISO/CASCO works both on the principles and practice of conformity assessment, developing documents published as ISO/IEC International Standards or Guides (ISO, 2005). The voluntary criteria contained in these documents represent the international consensus on good practice, thereby facilitating the mutual recognition of conformity assessment results. ISO/CASCO’s objectives are:

1) To study the means of assessing the conformity of products, processes, services, and management systems to appropriate standards or other technical specifications

2) To prepare standards and guides related to the practice of testing, inspection and certification of products, processes, and services and to the assessment of management systems, testing laboratories, inspection, certification and accreditation

bodies, and their operation and acceptance

3) To promote mutual recognition and acceptance of national and regional conformity assessment systems as well as the appropriate use of International Standards for testing, inspection, certification, assessment, and related purposes (ISO, 2005)

There are two other important international organizations that deal with conformity assessment affairs: one is the International Accreditation Forum (IAF), and the other is the International Laboratory Accreditation Cooperation (ILAC). IAF is an international association of organizations that have agreed to work together on a worldwide basis to achieve common trade facilitation objectives. As a major world forum for developing the principles and practices for the conduct of conformity assessment to deliver the confidence needed for market acceptance, IAF acts through the accreditation of those bodies that certify management systems, products, personnel, and/or inspection (IAF, 2008). ILAC is a form of international cooperation between the various laboratory accreditation schemes operated throughout the world; it is also the world's principal international forum for the development of laboratory accreditation practices and procedures, promotion of laboratory accreditation as a trade facilitation tool, assistance in developing accreditation systems, and recognition of competent test facilities across the globe. Over 40 laboratory accreditation bodies have signed the multi-lateral, mutual recognition arrangement ("ILAC Arrangement") to promote the acceptance of accredited test and calibration data. This "ILAC Arrangement" provides significant technical underpinning to international trade (ILAC, 2009).

3.1.1 Definitions and Purposes

Initially, conformity assessment was cited in ISO/IEC Guide 2 as part of the standardization process. In 2002, the ISO/CASCO committee assumed responsibility for regulating all the conformity assessment standards and guidelines and decided to create its in-contained vocabulary. As a result, the basic definitions of conformity assessment are compressed in the ISO/IEC 17000:2004 *Conformity Assessment — Vocabulary and General Principles*. This document defines the key terms related to conformity assessment as follows:

- Conformity Assessment: demonstration that the specified requirements related to product, process, system, person, or body are fulfilled.

The subject field of conformity assessment includes activities defined elsewhere in this International Standard, such as testing, inspection, and certification as well as the accreditation of conformity assessment bodies. The expression "object of conformity assessment" or "object" is used in this International Standard to refer to any particular material, product, installation, process, system, person, or body to which conformity assessment is applied. Service is covered by the definition of a product.

- Conformity Assessment Parties

Conformity assessment activities can be characterized as "first-party," "second-party," or "third-party." Generally, for each of these categories, conformity assessment activities are under the control or direction of the type of individual or body stated in the definition; the critical decision on which attestation is based is made according to the type of individual or body stated in the definition.

1) First-party conformity assessment activity: conformity assessment activity performed by the person or organization providing the object.
2) Second-party conformity assessment activity: conformity assessment activity performed by a person or an organization with user interest in the object.
3) Third-party conformity assessment activity: conformity assessment activity performed by a person or a body independent of the person or organization providing the object and of user interests in that object.

The first-, second-, and third-party descriptors used to characterize conformity assessment activities with respect to a given object are not to be confused with the legal identification of the relevant parties to a contract. Persons or organizations performing second-party conformity assessment activities include purchasers or users of products or potential customers seeking to rely on a supplier's management system or organizations representing those interests. The criteria for the independence of conformity assessment bodies and accreditation bodies are specified in the International Standards and Guides applicable to their activities.

- Certification: third-party attestation related to products, processes, systems, or persons.

The certification of a management system is also sometimes called registration. Certification is applicable to all objects of conformity assessment except the conformity assessment bodies themselves, to which accreditation is applicable.

- Accreditation: third-party attestation related to a conformity assessment body that formally demonstrates its competence to carry out specific conformity assessment tasks.

Conformity assessment is the process wherein a known competent body issues a statement (e.g. a report or certificate) that a particular process, system, product, etc complies with a specified requirements, e.g. as given in a standard or specification. The competence of a conformity assessment body is often demonstrated when it is accredited by an accreditation body. Conformity assessment provides benefits to manufacturers and service providers, consumers, and government regulators as well as for international trade in general.

For conscientious manufacturers and service providers, having their products assessed and certified as conforming to a particular standard allows them to distinguish themselves from less reputable suppliers (ISO, 2005).

Consumers benefit from conformity assessment because it provides them with a basis for selecting products or services. They may have more confidence in products or services carrying a mark or a certificate of conformity attesting to quality, safety, or other desirable characteristics (ISO, 2005). Regulators benefit from conformity assessment since it gives them a means of enforcing governmental health, safety, and environmental legislation. Harmonizing conformity assessment procedures worldwide also has far-reaching benefits for international trade in general. Agreements among economies or regions on the mutual acceptability of requirements, assessment methods, inspection or test results, etc., can all help reduce or remove the so-called technical barriers to trade (ISO, 2005).

3.1.2 Conformity Assessment Activities

According to the conformity assessment definition and ISO/IEC 17000, conformity assessment activities include testing, inspection, certification and accreditation, etc. The conformity assessment activities, testing, certification and accreditation are described in detail later in this chapter. Inspection is introduced briefly as follows (Hesser, 2006):

- **Inspection**: This involves examining the product design, product, process, or installation and determining its conformity to specific requirements or -- on the basis of professional judgment -- to general requirements. The inspection of a process may include the inspection of persons, facilities, technology, and methodology. Inspections can be used to evaluate requirements and design prior to development to eliminate defects early, unlike testing. The formal process consists of a number of defined steps.

Who implements the conformity assessment activities mentioned above? Conformity assessment bodies carry out these activities. There are many different conformity assessment bodies such as management system certification bodies that can issue ISO 9001 certificates, testing and calibration laboratories that can issue testing reports and calibrating reports, and inspection bodies that can issue inspection reports. Note that an accreditation body is not a conformity assessment body, since an accreditation body is the authoritative body performing accreditation. The authority of an accreditation body is usually derived from the national government. The accreditation body accredits the conformity assessment body for compliance with a standard such as ISO/IEC 17025(for laboratories). If a conformity assessment body is accredited by an accreditation body, it demonstrates that the body has the competence to carry out specified conformity assessment activities. In general, conformity assessment bodies are for-profit organizations, whereas accreditation bodies are non-profit entities.

Typical conformity assessment bodies that carry out conformity assessment activities such as testing, inspection, certification, or their combination are as follows (Song, 2009):

- **Laboratories**: These test or measure samples or items using validated scientific methods to determine particular characteristics and compliance with standards or specifications. Laboratories can be classified as either “testing” or “calibration” laboratories.
- **Inspection bodies**: These examine individual products, services, and processes using measurement and professional judgment to establish compliance with standards or specifications.
- **Systems certification bodies**: These certify organizations for compliance with

management system standards, e.g., quality management system standards (ISO 9001) or environmental management systems (ISO 14001).

- **Product certification bodies**: These grant certificates for manufacturers to mark their products as compliant with particular standards or specifications. Decisions to grant such certificates are, in part, based on testing and inspection reports on prototypes or selected examples of the product plus other criteria, e.g., packaging and labeling.
- **Personnel certification bodies**: These certify personnel as qualified with respect to the defined criteria or standards, e.g., certified auditors undertaking ISO 9001 and ISO 14001 audits.

Case: Some Accreditation Bodies and Conformity Assessment Bodies in APEC

CHINA: As the national accreditation body of China, CNAS or China National Accreditation Service for Conformity Assessment is unitarily responsible for the accreditation of certification bodies, laboratories, and inspection bodies (CNAS, 2008). CQC or China Quality Certification Centre is a conformity assessment body accredited by CNAS. As the largest professional certification body in China, it deals with product certification such as the China Compulsory Certification (CCC), voluntary certification, management system certification, and certification training services as its core business (CQC, 2009).

JAPAN: There are two important accreditation bodies in Japan: JAB (Japan Accreditation Board for Conformity Assessment), which carries out operations concerning conformity assessment such as the accreditation and registration of registration bodies, personnel certification bodies, training bodies, etc.; JNLA (Japan National Laboratory Accreditation System), which has been established to evaluate and accredit competent testing laboratories. There are many conformity assessment bodies in Japan such as JAQ (Japan Quality Assurance Organization), a famous body in Asia.

USA: The US's conformity assessment system has some differences with other APEC economies. In the accreditation area there are many organizations related to accreditation activities. For instance, NIST/NVCASE and A2LA among others provide accreditation activities in the US. NIST or National Institute of Standards and Technology offers NVCASE or National Voluntary Conformity Assessment Systems Evaluation Program to evaluate and recognize organizations supporting conformity assessment activities. A2LA or American Association for Laboratory Accreditation provides comprehensive services in laboratory accreditation and laboratory-related training and offers programs for the accreditation of inspection bodies, proficiency testing providers, reference material producers, and product certification bodies..

3.1.3 Importance of Testing Activities

Testing involves determining one or more characteristics of an object of conformity assessment according to a procedure; it typically applies to materials, or products. Testing is one of the most common forms of conformity assessment. Here, a product is tested against a specified set of criteria to make a decision on the compliance of the product with a specification or other requirement. For example, tensile testing is a test performed according to ASTM A370 (standard test methods and definitions for the mechanical testing of steel products) to measure the resistance of a material to static or slowly applied force. The laboratory that carries out testing activities is called a testing laboratory. If the laboratory is accredited by an accreditation body for compliance with ISO/IEC 17025, it is authorized to issue test reports.

For example, CQC has the license to issue the China Compulsory Certification (CCC) for products since its testing laboratories have passed the laboratory accreditation. It also has authorization to issue CCC Marks by CNAS.

Testing activities play an important role in many fields. The impact of testing activities can be seen as follows (Song, 2002):

- **Trade facilitation**: Various testing activities may be carried out to show compliance with the importing economy's requirements. This is vital for the international acceptance of product and to facilitate an unimpeded exchange of goods and services leading to cost reductions. At the international level, this is easy to understand considering the technical and non- technical barriers to trade and the cost incurred by importers, exporters, and governmental entities wherein the lack of effective framework and competent conformity assessment bodies would limit the possibility of national companies gaining access to foreign markets.
- **Consumer protection**: The major benefit is enjoyed by the consumer through the quality of the products. Here, quality is considered based on the technical level as meeting the specified minimum requirements and protecting human and consumer rights.
- **Environmental protection**: The mass production methods, geographical population explosion, contamination challenges that are expected to be solved, climatic changes, new ideas related to sustainable development, and green consumption orientation require society to innovate and search for new means of establishing relationships with the environment. The testing activities focus on reducing the negative impact on the environment, the reduction of chemical residues in the whole production chain, and encouraging the use of cleaner methods of production.

3.1.4 Types of Certification Systems and Characteristics

There are many kinds of certifications and categorizing methods for classifying them. Generally, certifications are classified in terms of their characteristic natures and certifying objects.

By nature, certification can be divided into compulsory certification and voluntary certification. For example, CCC product certification is compulsory certification. Most management system certifications are voluntary certifications such as the quality management system certification based on the ISO 9001 standard.

According to the certifying objects, certifications can be divided into product certification, management system certification, and personnel certification.

Product certification is the process of certifying that a certain product has passed performance and quality assurance tests based on some regulations and/or standards. A product with a quality certificate means that the product quality conforms to the requirements stipulated in the regulations and standards. According to the ISO 9000:2005 standard, there are four generic product categories: services (e.g., transportation); software (e.g., computer program, dictionary); hardware (e.g., engine, mechanical part), and; processed materials (e.g., lubricant). Many products are made up of elements belonging to different generic product categories. Whether the product is called service, software, hardware, or processed material depends on the dominant element. Thus, product certifications include service, software, hardware, or processed material certifications. Product certification can be categorized into compulsory certification and voluntary certification. CE Marking is compulsory certification, i.e., the quality of the product must conform to the EU directives. UL certification is voluntary certification.

A management system involves establishing policies and objectives and achieving those objectives. The management system of an organization can include different management systems such as quality management system, financial management system, or environmental management system. Management system certification is the process of certifying that a certain management system has complied with some regulations and/or standards. An organization acquiring such certificate means that its management system conforms to the requirements stipulated in the regulations and management standards. There are many types of management system certifications: quality management system certification (e.g., ISO 9001 certification); environmental management system certification based on ISO 14001; occupational health and safety management system certification based on OHSAS 18001; social accountability certification (e.g., SA 8000 certification), etc.

Personnel certification is the process of certifying that a person has the competence and capabilities stipulated in some regulations and/or standards. This certificate can prove that the person's competence and capabilities conform to the requirements stipulated in the regulations and standards. Major international standards for personnel certification include ISO/IEC 17024:2003 *Conformity Assessment* -- *General Requirements for Bodies Operating the Certification of Personnel* and ISO 19011 *Guidelines for Quality and/or Environmental Management Systems Auditing*. The latter ISO standard stipulates the competence and evaluation of auditors who audit the quality management system based on ISO 9001 and the environmental management system based on ISO 14001. In ISO 19011, basic requirements such as personal behaviors, knowledge and skills, generic knowledge and skills of management system auditors, generic knowledge and skills of the audit team leader, specific knowledge and skills of management system auditors, education, work experience, training and audit experience of auditors, auditors' competence, etc., are specified.

In addition, as per ISO/IEC 17000, conformity assessment activities can be characterized as "first-party", "second-party," or "third-party." First-party certification or self-certification is the process wherein an organization (e.g., manufacturer or supplier) declares that the product meets one or more standards. This process is also known as a declaration of conformity by a manufacturer or a supplier. Compared with third-party certification, first-party certification has the following distinctive characteristics:

1) Enhances the first-party organization's confidence in the quality control system.
2) Declarations have not been verified by an independent body

The first-party organization's capability, integrity, and reputation determine the degree of confidence in this type of certification. There are some tendencies of increasing the adoption of first-party conformity assessment instead of third-party conformity assessment in some product areas.

Comparatively, in a third party certification system:

1) The quality control system of the first party is typically reviewed by the third party to ensure conformance with applicable requirements.
2) Independent verification that the product complies with the requirements of the applicable test standard is provided.

3.2 System Certifications

System certifications focus on management systems conforming to some standards. Management systems include quality management system, environmental management system, health management system, food safety management system, etc.

3.2.1 Quality Management Systems

A management system refers to any of the systems that are set up to establish policies and goals and realize these goals. The quality management system is part of the management systems of an organization. A quality management system (QMS) -- according to the ISO 9000:2005 standard -- refers to the management system that directs and controls an organization with regard to quality. ISO 9001:2008 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 to achieve the quality policies and objectives (Paulo, 2007), seeking to satisfy customers by meeting their requirements as well as the applicable laws and regulations.

● ISO 9000 family of standards

Primarily concerned with "quality management," the ISO 9000 family of standards has become an international reference for quality management requirements in business-to-business dealings. Organizations adopting these standards should fulfill the following (Hesser, 2006):

1) Customer's quality requirements;
2) Applicable regulatory requirements while aiming to --
3) Enhance customer satisfaction and to --
4) Realize continual performance improvement in pursuit of these objectives.

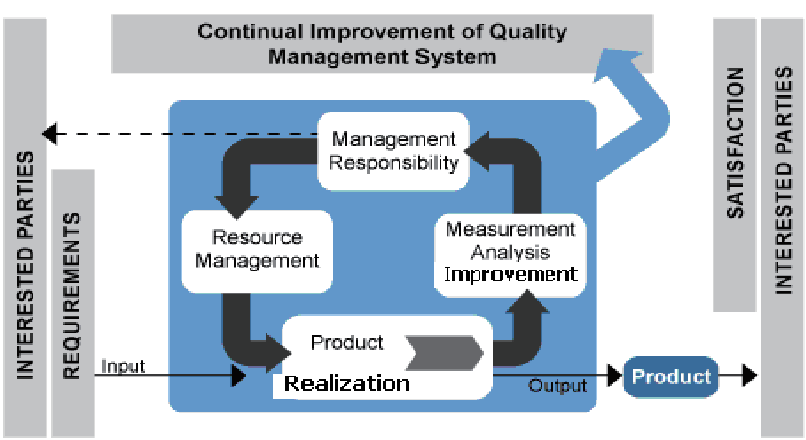
There are four main standards in the latest edition of the ISO 9000 family of standards as follows:

ISO 9000:2005	Quality management systems – Fundamentals and vocabulary
ISO 9001:2008	Quality management systems – Requirements
ISO 9004:2009	Managing for the sustained success of an organization –A quality management approach
ISO 19011:2002	Guidelines for quality and/or environmental management systems auditing

◀Fig.3-2 The Main Standards of the ISO 9000 Family of Standards

● Introduction of ISO 9001:2008

As a member of the ISO 9000 family of standards, the ISO 9001:2008 standard stipulates the quality management system requirements. It specifies the minimum requirements for the quality management system of an organization, ranging from management responsibilities, and supply of resources, product realization, measurement analyses, and continual improvement. Its purpose is to satisfy customer requirements and applicable regulations. ISO 9001 can be applied to all types of organizations regardless of size or function; it can help both product-oriented and service-oriented organizations meet quality standards. This standard provides common guidelines and suits not only all trade and economic fields but also products of any type. This standard adopts quality management system modes based on process management and customer satisfaction. The requirements of process management are illustrated as follows:



◀Fig. 3-3 Features of ISO 9001 (source: Hesser, 2006)

● Quality management system based on ISO 9001

The ISO 9001 standard requires organizations to create documents relevant to quality management systems. Quality management system documents should deal with all or part of the activities of the organization and include the following four types of documents at the very least (Song, 2009): quality policies and objectives, quality manual, procedure documents, and quality records required by the standards.

Quality manual: Organizations must compile and maintain the quality manual according to the ISO 9000 standards requirements. The quality manual should include at least the scope of the quality management system, documented procedures required for the quality management system, processes of the quality management system, and description of their mutual relationship.

Procedure documents: A procedure is the specified approach to carry out some activity or process. Each documented procedure must answer the 5W1H questions, i.e., why, what, who, when, where, and how.

Records: These are files that record the achieved results or supply the evidence for the fulfilled activities. To meet the requirements and supply evidence for quality management system operation, organizations must make records and subsequently maintain and control them (Song, 2009).

● Quality management system certification

According to ISO 9001 standard and quality management system documents, the ISO 9001 quality management system certification follows the auditing procedures prescribed by ISO 19011 standard and gives written guarantees to the organization whose quality management system meets the specific requirements. The following are the procedures for quality management system certification: application, quality system audit, corrective action, submission of auditing reports and deliberation, issues and publication certificate, supervision and management.

● Quality management system certification statistics

According to the ISO survey, as of the end of December 2007, at least 951 486 ISO 9001:2000 certificates had been issued in 175 economies and economies. The 2007 total represents an increase of 54 557 (+6%) compared to 2006's total of 896 929 in 170 economies and economies. The top economy in terms of the number of certificates was China (ISO, 2008).

World results	Dec. 2003	Dec. 2004	Dec. 2005	Dec. 2006	Dec. 2007
World total	497 919	660 132	773 867	896 929	951 486
World growth	330 795	162 213	113 735	123 062	54 557
Number of countries/ economies	149	154	161	170	175

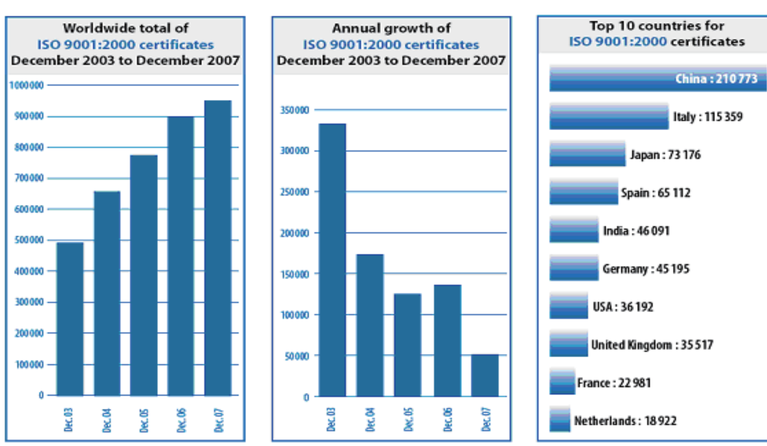


Fig. 3-4 ▶ Number of Third-Party Certifications Based on ISO 9001:2000 (Source: 2007 ISO Survey, 2008)

3.2.2 Environmental Management System

More than a century of industrial development is now believed to have come at a price -- global warming, depletion of the ozone layer, air and water pollution, soil erosion, and deforestation, which are widely acknowledged as the major environmental issues of today (Cristiana, 2005). The past few decades have seen an increased awareness of the environment by governments, companies, 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 providing high-quality, environment-friendly products and services are likely to have greater potential to capture a large market share as well as huge returns. This seems to be evident among multinational companies (MNC), which have been practicing environmental management as a corporate strategy. According to previous research, many successful companies provide excellent examples as to how well-formulated environmental strategies could translate into business advantages such as better quality, reduced costs, improved company image, relations with customers, and opening of new markets.

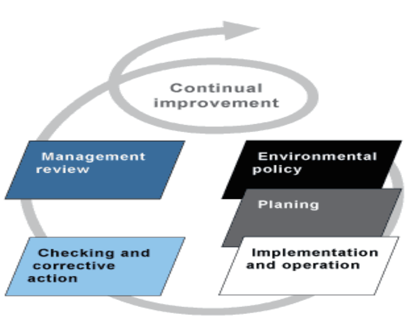
By implementing an Environmental Management System (EMS), companies could integrate environmental values into their operations. A company implementing an EMS accepts the responsibility of protecting the environment and ensuring the continual improvement of its environmental performance.

● Environmental Management Systems (EMSs)

Established by ISO in 1996, the ISO 14000 family of standards presents a common framework of tools for managing environmental issues. ISO 14001 is considered the world's most recognized EMS framework; the standard was originally published in 1996 and revised in 2004 by ISO/TC 207. The family includes standards for environmental management systems, terms and definitions, environmental auditing, environmental performance evaluation, environmental labeling, and life cycle assessment (ISO, 2009).

● ISO 14001 Standard

Among the ISO 14000 family of standards, ISO 14001 is the main standard providing the EMS model. ISO 14001 EMS has the following five components (Nicole, 2006): environmental policy, planning, implementation and operation, checking and corrective action, and management review.



◄Fig. 3-5 Structure of EMS (source: Hesser, 2006)

● Development and Certification of EMS

Developing EMS for ISO 14001 involves the collection of the policies and procedures of a company for environment-related functions, defining its organizational structure, and identifying the laws and regulations governing it. The ISO 14001 standard strongly recommends that companies without existing EMSs carry out an initial review of their current management systems to determine if their procedures and practices can be incorporated into the formal requirements of the ISO 14001 standard. ISO 14001 is basically a documented management system; as part of such, an environmental manual as well as 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, health, and safety. Generally, many organizations establish the EMS together with the QMS based on ISO 9001 at the same time, so they only need once auditing activities by the certification bodies to get the EMS certificate and the QMS certificate. Since the certification procedures and auditing processes are the same, any auditing activity related to the documents, on-site audits, supervision, and management must conform to ISO 19011 as their common standard.

The market appears to be the main driver behind a company's environmental strategy to implement ISO 14001. For example, a survey reveals that 50% of the companies have implemented the EMS due to customer demand or competitive advantage of certification (Chialin, 2001). Another study carried out in far eastern economies including Japan, Korea, and China cited corporate image, environmental improvement, market advantage, and improved relations with communities as the most important reasons for certification.

● Environmental management system certification statistics

Based on the ISO survey, as of the end of December 2007, at least 154 572 ISO 14001:2004 certificates had been issued in 148 economies and economies. The 2007 total represents an increase of 26 361 (+21%) compared to 2006's total of 128 211 in 140 economies and economies. The top economy in terms of the number of certificates was China (ISO, 2008).

Fig. 3-6 ▶ Number of Third-Party Certifications Based on ISO 14001:2004 (source: 2007 ISO Survey, 2008)

World results	Dec. 2005		Dec. 2006	Dec. 2007
	Total	of which ISO 14001:2004		
World total	111 162	56 593	128 211	154 572
World growth	21 225	–	17 049	26 361
Number of countries/ economies	138	107	140	148

3.2.3 Other System Certifications

There are many other management system certifications besides those mentioned above. Some of them are introduced briefly as follows:

● SA 8000 Social Accountability Management System

Social responsibility is the ethical or ideological theory stipulating that an entity -- be it government, corporation, organization, or individual -- has a responsibility to society at large. SA 8000 is a global social accountability standard for decent working conditions as developed and overseen by Social Accountability International (SAI). SA 8000 is based on the UN Universal Declaration of Human Rights, Convention on the Rights of the Child, and various International Labor Organization (ILO) conventions. SA 8000 covers the following areas of accountability: child labor, forced labor, workplace safety and health, freedom of association and right to collective bargaining, discrimination, discipline, working hours, remuneration, and management system for human resources.

● Hazard Analysis and Critical Control Points

A systematic preventive approach to food safety and pharmaceutical safety, Hazard Analysis and Critical Control Point (HACCP) addresses the physical, chemical, and biological hazards as a means of prevention rather than finished product inspection. HACCP is used in the food industry to identify potential food safety hazards so that key actions -- known as Critical Control Points (CCPs) -- can be taken to reduce or eliminate the risk of the hazards being realized. The system is used at all stages of food production and preparation processes including packaging, distribution, etc.

HACCP is related to the international standard ISO 22000:2005 “Food Safety Management.” ISO 22000:2005 specifies the requirements for a food safety management system wherein an organization in the food chain needs to demonstrate its ability to control food safety hazards to ensure that food is safe at the time of human consumption. This standard is a complete food safety management system incorporating the elements of prerequisite programs for food safety. Together, HACCP and quality management system form an organization’s Total Quality Management.

● OHSAS 1800 Health and Safety Management

As an Occupation Health and Safety Assessment Series for health and safety management systems, OHSAS 18001 is intended to help an organization control occupational health and safety risks. It was developed in response to widespread demand for a recognized standard against an organization to be certified and assessed. OHSAS 18000 is an international occupational health and safety management system specification consisting of two parts: 18001 and 18002. It embraces a number of other publications. Just like the EMS, it is a self-regulatory management tool instead of a fixed set of safety guidelines. Thus, companies wishing to implement the standard can customize its requirements to meet their specific needs. Note that the standard has not yet been adopted by ISO.

Except those mentioned above, other management system certifications are ISO/ IEC 20000 IT Service Management Certification, AS 9000 Aerospace Industries Quality Assurance Certification, etc.

3.3 Product Certification System

Suppliers or organizations can use several ways to indicate certain characteristics of their products including the following:

1) Pictograms – often used to give advice to users, e.g., how to wash clothes
2) Logos and trademarks with a certain image related to it, e.g., Coca-Cola, Nike, and Rolex
3) Self-declaration of conformity providing statements about the product's quality, e.g., conformity labeling.
4) Marks of conformity or certification issued by a third party, e.g., NF (France), SNI (Indonesia)

The latter is for product certification. As mentioned earlier, product certification can be divided into compulsory certification and voluntary certification. In general, the former satisfies the safety requirements, and the latter, the market requirements. As the logo of product certification, the certified mark is often affixed on the product or its package. Every type of product certification has its respective certified mark.

3.3.1 Certification System of Major Product Markets

Product certification is primarily a commercial instrument for enterprises; the choice of certificated mark on the product can stimulate market acceptance. Due to the costs 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 expands the options when making an offer. Whether this translates into actual order depends on the price, delivery time, and quality perception (what the supplier offers and/or which expectations are exceeded, e.g., delivery to special locations, gift packaging, spread of payment, etc.) (Jeffcoat, 2002), among other factors. 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, which need it as a "flag to wave." As a consequence, the added value of a certificate on a well-known product is less for an unknown product that can use the "backup support" provided by a certificate for entering the market.

Some products, e.g., cable and wire, switches for circuits, installation protection or connection devices, household and similar electrical appliances, etc., sold in China markets must obtain CCC marks for their safety requirements. In December 2000, the General Administration of Quality Supervision, Inspection, and Quarantine of the People's Republic of China (AQSIQ) issued the Regulations for Compulsory Product Certification. CCC or 3C for short, the China Compulsory Product Certification is a compulsory safety certification system. As the basic approach that safeguards consumers' rights and interests and protects personal and property safety, it is adopted widely by international organizations. The Compulsory Product Certification covers 135 products divided into 20 categories including household appliances, motor vehicles, motorcycles, safety glasses, medical devices, lighting apparatus, cables and wires, etc. CQC is tasked with the work of compulsory product certification for 17 categories within the CCC catalogue (CQC, 2009).

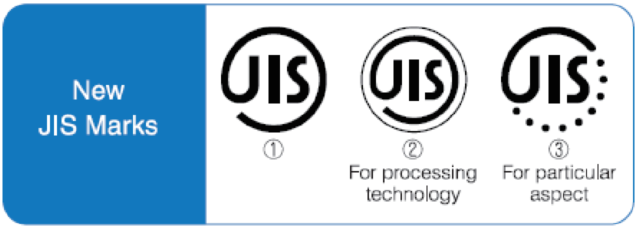
◀Fig. 3-7
CCC Mark
(source: CQC, 2009)

Case: JIS Mark Scheme

The JIS Mark Certification Scheme certifies conformity to the Japan Industrial Standards (JIS); it has been implemented since 1949. The New JIS Mark Certification Scheme based on the revised Industrial Standardization Act enacted in October 2005 is an internationally harmonized third-party certification system for products under which private certification bodies accredited by the government (Accredited Certification Bodies) conduct certification activities. In the new scheme, the former designated product system (system under which the government designated products subject to the old JIS mark labeling) has been abolished, and all products that can be certified are now covered by the new scheme; thus increasing the flexibility of the scheme. Furthermore, the JIS mark has been redesigned, adding a new mark for specified aspects such as environmental consciousness and safety. On the other hand, the old JIS Mark Certification Scheme was abolished on September 30, 2008.

The Japan National Laboratory Accreditation (JNLA) system has been put in place to evaluate and to accredit the competent test method of JIS. Accredited testing laboratories are entitled to issue test reports with the JNLA symbol. Since the launch of the New JIS Mark Certification Scheme in 2005, all JIS-specified tests have been included in the scope of the JNLA system. With this, the method of evaluating and indicating conformity to JIS has been enhanced. Accreditation of testing laboratories is required to evaluate whether the laboratory conforms to the requirement of ISO/IEC 17025. Therefore, the test reports of accredited testing laboratories are internationally accepted.

Currently, 151 testing laboratories have been accredited by JNLA (as of the end December 2008); over 30,000 test reports are also issued annually, covering a wide range of areas including civil engineering/construction, iron/steel, and textiles (JISC, 2008).



◀Fig. 3-8
New JIS Marks
(source: JISC Annual Report, 2008)

According to Fig. 3-8, the new mark comes in three different types:

1) Mark that can be affixed on any product conforming to the JIS product standards
2) Mark that can be affixed for processing technology
3) Mark indicating conformity to JIS, which stipulates some particular aspects such as performance, safety, etc.

With regard to the mark for particular aspects, this type of mark may be affixed by the establishment of a new standard or a revision of JIS depending on the need.

Case: NRTL Certification Mark (United States)

A number of U.S. Occupational Safety and Health Administration (OSHA) standards contain requirements for “approval” of specific products by an NRTL. NRTLs are third-party (i.e., independent) organizations recognized by OSHA as having the technical capability to perform safety testing and certification of particular types of products. NRTLs provide testing and certification services to the manufacturers of a wide range of products used in the workplace. An NRTL’s approval of a product generally consists of testing, inspection and certification. Testing involves determining whether a sample or prototype of the product meets the applicable requirements of one or more specific consensus-based, U.S. product safety test standards. If the product meets the test standard requirements, the NRTL then performs an initial inspection of the factory that manufactures, or will manufacture, the product to verify that the products resulting from production runs are or will be in conformance with the test standard’s requirements. Following a satisfactory initial inspection, the NRTL issues its certification which provides assurance that the product conforms to the specific test standard(s). The NRTL also authorizes the manufacturer to apply the NRTL’s mark to each unit of the manufactured product. After issuing its certification, the NRTL conducts periodic follow-up (i.e., quality-assurance and compliance) inspections of each manufacturing facility to provide assurance that the product currently manufactured at the facility and bearing the NRTL’s mark is identical to the product that the NRTL tested and certified.

After certifying a product, the NRTL authorizes the manufacturer to apply the NRTL’s registered certification mark to the product. Generally, the manufacturer applies the mark to the products at the time the products are manufactured. If the certification is done under the NRTL Program, this mark signifies that the NRTL tested and certified the product, and that the product complies with the requirements of one or more appropriate product safety test standards. Users of the product can generally rely on the mark as evidence that the product complies with the applicable OSHA approval requirement(s) and is safe or safety compliant.

OSHA has recognized 15 organizations, including Communication Certification Laboratory, Inc. (CCL), Intertek Testing Services NA, Inc. (ITSNA), Underwriters Laboratories Inc. (UL), that operate over 100 sites around the world.

3.3.2 International Certification Systems of IEC

To illustrate the types of Certification Systems, the International Electrotechnical Commission (IEC) should be considered. This organization wields significant impact on technological development worldwide because it regulates all the international standards in the electrotechnical field. Toward this end, IEC has designed three schemes to perform certification.

IEC has three multilateral conformity assessment systems: IECEE, IECQ, and

IECEx. Using IEC standards for certification at the national level ensures that a certified product has been manufactured and type-tested according to well-established international standards. The end user can be sure that the product meets the minimum (usually high) quality standards, and that he/she does not need to concern himself/herself with further testing or evaluation of the product.

- IECEE:

IECEE handles assessment of conformity to standards for electrical and electronic equipment and includes photovoltaic (PV). It operates two schemes: CB Scheme and CB-FCS (IECEE, 2009).

1) CB Scheme

This is for the Mutual Recognition of Test Certificates for Electrotechnical Equipment and Components. The fundamental principle of the CB Scheme is that a manufacturer can obtain a CB Test Certificate for a defined product from a national certification body (NCB). The manufacturer can then present this certificate to the NCBs in other member economies to obtain certification marks from them for its products. The CB Scheme is based on the principle of mutual recognition by its members of test certificates for the purpose of issuing third-party certification marks at the national level. Members of the scheme commit themselves to recognizing the CB Test Certificate issued by any certification body to operate within the scheme. An essential part of this is peer assessment. Experience shows that -- in addition to promoting confidence among the members of the CB Scheme -- Peer Assessment as a method of verifying competence and building confidence is accepted by authorities and clients of testing and certification bodies to have at least the same weight as accreditation.

2) CB-FCS Scheme

This is for the Mutual Recognition of Conformity Assessment Certificates for Electrotechnical Equipment and Components. “FCS” in CB-FCS stands for “Full Certification Scheme.” As to the major differences between the CB Scheme and the CB-FCS, system reports are also recognized, audits of manufacturers’ quality system are based on ISO 9002, organization “B” shall not request for samples unless national differences are not covered, tests are missing, etc., and organization “B” shall not repeat tests unless the report carries mistakes or the national differences are not covered.

3) CB Certificate Statistics

Based on the IECEE survey, as of the end of 2007, at least 50 392 CB certificates had been issued in 50 economies in relation to 62 national certification bodies. The top economy in terms of the number of certificates was China (IECEE, 2009).

Fig. 3-10 ▶ Number of Economies, Bodies, and Laboratories Joining the IECEE CB Scheme (Source: IECEE, 2009)

	Economies	NCBs	CBTLs
2001	41	53	129
2002	42	56	141
2003	43	58	150
2004	43	58	170
2005	44	58	195
2006	46	59	246
2007	50	62	234
2008(So far…)	50	66	247

Fig. 3-11 ▶ Number of IECEE CB Scheme Certificates (source: IECEE, 2009)

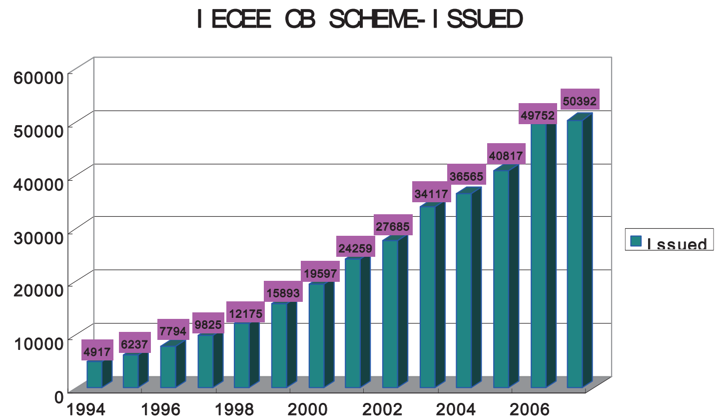
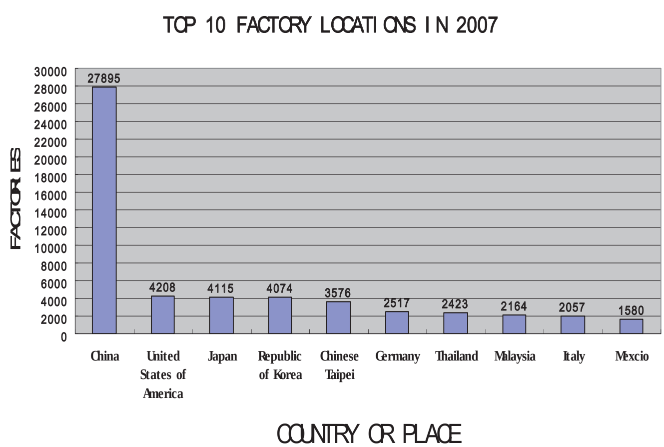


Fig. 3-12 ▶ Top 10 Factory Locations Joining the IECEE CB Scheme (source: IECEE, 2009)



- IECEx:

This is an International Certification Scheme covering products that meet the requirements of international standards, e.g., IEC standards prepared by TC 31; it can provide a single international certificate of conformity or approval process for economies where regulations still require the issuance of national Ex certificates. By providing an international certification scheme, IECEx makes it easier for manufacturers of equipment intended for use in explosive atmospheres to sell their products globally. The driving force comes from the manufacturers and users of Ex products. Manufacturers are offered a single test and assessment report for acceptance in all other participating economies. IECEx provides one international database listing, enhances international confidence in the product assessment process, reduces testing and certification costs for manufacturers, and shortens the time to market. The testing and assessment of Ex products are more complex and time-consuming than non-Ex products and are consequently costlier. The typical time to acquire national certification is 12 months or more. The IECEx System eliminates multiple testing and assessment; it caters to different economies whose national standards are either identical to those of IEC or very close to the IEC standards.

The IECEx System has a two-path approach with two objectives in mind (IECEx, 2009): to accommodate the needs and concerns of today and the immediate future through a well-defined, practical transitional period, and; to provide a path toward the ultimate aim of using one international certificate and mark accepted by all participating economies.

- IECQ

The purpose is to secure visibility and independent verification that electronic components and related materials and processes -- including those below the user's level of specification in the supply chain -- are compliant with appropriate standards, specifications, or other documents.

IECQ is a comprehensive worldwide program that assesses electronic components' compliance with the quality requirements and certifies their conformity to standards. It covers electronic components and related materials and processes, manufacturers and distributors, specialist contractors, testing laboratories, and hazardous substance process management, offering various approval procedures according to the circumstances (IECQ, 2009). Compliance with ISO 9001 or ISO/IEC 17025 (as relevant) is a prerequisite to being involved in IECQ.

One of the world's leading consumer electronics equipment manufacturers is requesting for IECQ-certified components from its suppliers. IECQ also certifies avionics manufacturers' Electronic Component Management Plans.

The Conformity Assessment Board or CAB represents IEC's conformity assessment community. It sets IEC's conformity assessment policy and oversees all IEC conformity assessment activities (IECEE, IECQ, and IECEx). CAB's policy is a non-discriminatory one. It seeks to help the industry avoid unnecessary obstacles to trade and to encourage different economies to harmonize their national standards and certification activities. CAB focuses on transparency; its initiatives target areas where a clear market need is identified for the benefit of suppliers and users. CAB's objectives are one test, one certification, and one mark (as applicable).

3.4 Conformity Assessment and Multilateral / Mutual Recognition Arrangements and Agreements

An MLA / MRA (Multilateral / Mutual Recognition Arrangements or Agreements for conformity assessment) is an agreement that specifies 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 facilitate trade and provide effective market access throughout the territories of the economies with regard to the conformity assessment results for all services and products covered under the arrangement or agreement.

3.4.1 Conformity Assessment and International Trade

The relationship between international trade and conformity assessment is that the latter can facilitate the free flow of goods and services, and reduce costs by eliminating the need for retesting/recertification in the importing economy. According to its definition, however, conformity assessment is not directly involved in international trade. In fact, the level of conformity assessment is mostly decided by the level of standards and proficiency of testing. Only when the results of a conformity assessment are accepted or recognized by other economies or regions can it play an important role in international trade. Harmonizing conformity assessment procedures around the world has far-reaching benefits for international trade in general. These are procedures or requirements related to imports and market access -- which vary from economy to economy -- and deemed likely to prevent a foreign product from entering a economy. Arrangements or agreements among economies or regions on the multilateral or mutual acceptance of the results of a conformity assessment can help minimize or remove the technical barriers to trade. These arrangements or agreements are known as Multilateral/Mutual Recognition Arrangements or Agreements (MLAs/MRAs).

The World Trade Organization's Agreement on Technical Barriers to Trade (WTO/TBT Agreement) was established to ensure that technical regulations and standards as well as the procedures for assessing conformity to such do not create unnecessary obstacles to international trade. The World Trade Organization has increasingly recognized that technical barriers to trade are one of the main hindrances to the free flow of goods and services. The WTO/TBT Agreement recognizes the potentially important contribution of international standards and conformity assessment systems to improving the efficiency of production and facilitating international trade. Promoting the recognition in one economy of the conformity assessment results from other economies as a way of reducing barriers to trade, the WTO/TBT Agreement emphasizes that confidence in the continued reliability of conformity assessment results is a prerequisite for the recognition of the results of such assessments (Song, 2002). According to the Agreement, verifiable compliance with international standards or guides for the operation of accreditation, testing, inspection, and certification bodies is considered an indication of adequate technical competence. Many of the relevant standards and guides are ISO/IEC publications produced under the auspices of ISO/CASCO, the ISO committee on conformity assessment. ISO and World Trade Organization work increasingly closely to ensure that the abovementioned benefits are realized (ISO, 2005). The importance of the international standards and guides to conformity assessment as developed by ISO/CASCO to remove technical barriers to trade and facilitate the flow of goods and services is recognized by the World Trade Organization.

3.4.2 Objectives of MLAs/MRAs

The objectives of the Multilateral / Mutual Recognition Arrangements or Agreements are given the following scenarios:

International acceptance: MLAs/MRAs signatories consist of organizations that have agreed to work together on an international basis to achieve common trade facilitation objectives. Based on MLAs/MRAs, same principles and practices for the conduct of conformity assessment deliver the confidence needed for markets. MLAs/MRAs promote the international acceptance of "endorsed" certificates of conformity issued by inspection bodies, certification bodies, and testing and calibration laboratories accredited by an accreditation body that is a signatory to the MLA/MRA. An "endorsed" certificate is one that includes the accreditation mark of the accreditation body.

Trade encouragement: MLAs/MRAs are tools that help overcome the technical barriers to trade and facilitate international commerce between their member economies. MLAs/MRAs bring together -- on an international basis -- participating accreditation bodies that seek to facilitate international trade through the acceptance of endorsed certificates of conformity.

3.4.3 Effects of MLAs/MRAs

For many companies, the market is the world market. Therefore, they would incur huge costs if they had to modify their product according to the requirements of different national standards and if they had to demonstrate conformity to these standards using different national certificates. The first problem is solved by replacing national standards with international standards; the second problem asks for common certificates. In that case, only one issue remains: preferably, a certificate issued in economy A is also recognized in economy B. In order to achieve the latter, so-called Multilateral Recognition Arrangements (MLAs) and Mutual Recognition Arrangements (MRAs) have been established.

Increasing trade freedom and development of new manufacturing and distribution technologies have facilitated the rapid growth of world trade. This in turn has resulted in the emergence of hundreds of third-party national and multinational conformity assessment bodies. These organizations examine a wide range of products, materials, installations, plants, processes, work procedures, and services in both private and public sectors. They also report on a wide range of parameters including quality, fitness for use, and continuing safety in operation. The overall aim is to reduce the risk to the buyer, owner, user, or consumer of the item.

The positive effect of the MLAs/MRAs in the international trade is evident for the signatories. Therefore, the number of MLAs/MRAs signed between all types of organizations is increasing substantially, creating more open markets and probably serving as the initial stage for free market interchange. Similarly, the members involved improve their bodies and generate more sophisticated tools for conformity assessment procedures (Hesser, 2006).

3.4.4 Important MLAs/MRAs

There are many MLAs/MRAs in the international markets. Some renowned MLAs/MRAs and theirs organizations are introduced briefly below.

● IAF MLA

The International Accreditation Forum, Inc. (IAF) is the international association of accreditation bodies and other bodies interested in conformity assessment in the areas of the certification of management systems, products, services, personnel, and similar programs. Its primary function is to develop a single worldwide program of conformity assessment that reduces the risk for business and its customers by assuring them that accredited certificates are reliable. Accreditation assures users of the competence and impartiality of the accredited body. IAF members accredit certification or registration bodies that issue certificates attesting to the compliance of an organization's management, products, or personnel with a specified standard (called conformity assessment). IAF's slogan is certified once, accepted everywhere (IAF, 2008).

The main purpose of IAF is to establish Multilateral Recognition Arrangements (MLA) between its accreditation body members. The object of these arrangements -- as the name suggests -- is to ensure the mutual recognition of accredited certification between signatories to the MLA and subsequent acceptance of accredited certification in many markets based on one accreditation. Accreditation body members of IAF are admitted to the MLA only after a stringent evaluation of their operations by a peer evaluation team. This team has the responsibility of assessing whether the applicant member complies fully with both the international standards and IAF guidelines. Once it is a member of the MLA, an accreditation body is required to recognize the competence and impartiality of accreditations of Conformity Assessment Bodies by all other members of the MLA.

IAF has granted Special Recognition to the MLA programs of three Regional Accreditation Groups -- European co-operation for Accreditation (EA), Pacific Accreditation Cooperation (PAC), and Inter-American Accreditation Cooperation (IAAC) -- based on acceptance of the mutual recognition arrangements established within these organizations. Membership of the IAFMLA is deemed satisfied by membership of either EA MLA, PAC MLA, or IAAC MLA for recognized programs.

The IAF MLA for Quality Management Systems (QMS) has been operational since 22 January 1998 when 14 IAF Members signed the Arrangement in

Guangzhou, China. The IAF MLAs for Environmental Management Systems (EMS) and Product Certification became operational during the IAF Annual Meetings held in Cape Town, South Africa in October 2004.

IAF encourages its members to join the MLA as soon as they have passed a rigorous evaluation process to ensure that their accreditation programs are on a par with the world standard. As a benefit of joining the IAF MLA, conformity assessment bodies accredited by the members of the MLA will be equally reliable in worldwide IAF Programs.

● PAC MLA

The Pacific Accreditation Cooperation (PAC) was formed in 1995 as an association of accreditation bodies and other interested parties sharing the objective of facilitating trade and commerce within the Asia-Pacific region.

Seeking to promote and contribute to the international acceptance of accreditations issued by its accreditation body members, PAC operates an MLA Program within the framework of IAF. International standards and guides and IAF requirements form the basis of the PAC MLA program, thereby ensuring harmonized accreditation procedures and their implementation among its members. This is achieved through regular and rigorous peer assessments of accreditation bodies' technical infrastructure, a mandatory requirement for membership to the MLA. The overall intent is that certification bodies accredited by PAC MLA signatories are recognized as equals, and that users of services can have the same confidence in the organizations accredited by one PAC member as in those accredited by other PAC members. Note that accreditation bodies that are members of both PAC and IAF can secure mutual recognition for their conformity assessment accreditations programs concurrently (i.e., separate peer evaluations and assessments need not be recognized by both regional and international communities). This is possible because PAC holds Special Recognition Regional Group status within IAF and endorses -- whenever possible -- IAF policies and procedures.

Accreditation bodies that wish to join the MLA must first and foremost comply with the requirements of ISO/IEC 17011:2004 *Conformity Assessment -- General Requirements for Certification Bodies Accrediting Conformity Assessment Bodies* as well as any related IAF mandatory document. In addition, they must demonstrate conformity to ISO 17021:2006 *Conformity Assessment -- Requirements for Bodies Providing Audit and Certification of Management Systems* and/or ISO/IEC Guide 65:1996 *General Requirements for Bodies Operating Product Certification Systems* depending on which accreditation program they would like to be recognized. ISO/IEC 17021 details the requirements associated with the accreditation of bodies that certify management systems including Quality Management Systems (QMS) and Environmental Management Systems (EMS). ISO/IEC Guide 65 (currently under revision to be published as ISO/IEC 17065) stipulates the requirements for the accreditation bodies of organizations that certify products.

As of the end of March 2010, signatories to the PAC MLAs numbered 15 for QMS, 12 for EMS, and 10 for the accreditation of Product Certification Bodies. PAC is also working in parallel with IAF to expand its program to include Food

Safety Management Systems (FSMS), Information Security Management Systems (ISMS), and accreditation of Certification Bodies for Persons.

PAC is also recognized by the Asia-Pacific Economic Cooperation (APEC) as one of the five Specialist Regional Bodies (SRBs) supporting the work of the APEC Sub-Committee on Standards and Conformance (SCSC). The 5 regional organizations forming the SRB Forum work collaboratively in accordance with the Principles of the SRB Forum document to "facilitate the development and implementation of standards and conformance infrastructure in each APEC member economy." To achieve this goal, the SRBs produced a Strategic Plan for Technical Infrastructure Development in Support of Trade Facilitation for and in APEC economies. Updated by the SRBs and endorsed by APEC SCSC on an annual basis, the Strategic Plan includes a 5-year action plan that outlines activities and mechanisms for SRBs to contribute to APEC SCSC programs and processes.

● ILAC MRA

The International Laboratory Accreditation Cooperation (ILAC) first started as a conference in 1977 with the aim of developing international cooperation for facilitating trade by promotion of the acceptance of accredited test and calibration results. In 1996, ILAC became a formal cooperation with a charter to establish a network of mutual recognition agreements among accreditation bodies that would fulfill this aim. On 2 November 2000, 36 laboratory accreditation bodies, 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 test and calibration data for exported goods. The arrangement came into effect on 31 January 2001. There are currently (March 2010) 64 ILAC Full Members (ILAC Arrangement signatories) representing 52 economies.

The 'ILAC Arrangement' provides significant technical underpinning to international trade by promoting cross-border stakeholder confidence and acceptance of accredited laboratory data. 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.

This arrangement is based on the results of an intensive evaluation of each accreditation body carried out by peers and in accordance with the relevant rules and procedures contained in several ILAC publications. Each accreditation body signatory to the Arrangement agrees to abide by its terms and conditions and by the ILAC evaluation procedures and shall:

1) Maintain conformance with the current version of ISO/IEC 17011, related ILAC guidance documents, and a few, but important, supplementary requirements, and
2) Ensure that all accredited laboratories comply with ISO/IEC 17025 or ISO 15189 (for medical testing laboratories) and related ILAC policy and guidance documents.

The ILAC Arrangement builds upon existing or developing regional arrangements established around the world. Each recognized Regional Cooperation Body must abide by the procedures defined in ILAC requirements documents. The European cooperation for Accreditation (EA), the Asia Pacific Laboratory Accreditation Cooperation (APLAC) and the Inter-American Accreditation Cooperation (IAAC) are the current ILAC-recognized regions with acceptable mutual recognition arrangements (MRAs) and evaluation procedures. For further information on the ILAC Arrangement refer to www.ilac.org (ILAC, 2009).

● APLAC MRA

The Asia Pacific Laboratory Accreditation Cooperation (APLAC) was initiated in 1992 as a forum for laboratory accreditation bodies in the Asia Pacific region. Its primary aim was to establish, develop and expand a mutual recognition arrangement among accreditation bodies in the region.

APLAC is recognized by the Asia Pacific Economic Cooperation (APEC) as one of the five Specialist Regional Bodies (SRBs) that support the work of the APEC Sub-Committee on Standards and Conformance.

The inaugural signing of the APLAC Mutual Recognition Arrangement (MRA) occurred on 19 November 1997, with 7 accreditation bodies signing the MRA for testing and calibration. The MRA was extended in November 2003 to include inspection, and in April 2007 to refer specifically to ISO 15189 (the international standard applied to medical laboratories) that had previously been included under the —testing scope of the MRA. The inaugural signing of the extended APLAC MRA to include the accreditation of reference material producers (RMPs) took place in December 2007. There are currently (January 2010) 31 signatories to the APLAC MRA.

The APLAC MRA is based on the results of an intensive evaluation of each accreditation body done in accordance with procedures detailed in the relevant APLAC publications. Each APLAC MRA signatory has demonstrated compliance with the international standard ISO/IEC 17011 and that its accredited facilities are in compliance with ISO/IEC 17025 (laboratories), ISO 15189 (medical laboratories), ISO/IEC 17020 (inspection bodies) and/or ISO Guide 34 in combination with ISO/IEC 17025 (RMPs). A re-evaluation is done at a maximum of 4-yearly intervals by a team of trained APLAC peer-evaluators. This MRA forms a regional network of laboratories and inspection bodies accredited by accreditation bodies that have been peer-evaluated and recognised as being competent. This network facilitates the acceptance of test, calibration and inspection reports in the region, thus contributing to the facilitation of trade and the free-trade goal of —tested/inspected once, accepted everywhere (APLAC, 2009).

● CIPM MRA

The International Committee for Weights and Measures (CIPM) is made up of 18 individuals each from a different member state under the Metre Convention (BIPM, 2002). Its principal task is to promote worldwide uniformity in units of measurement through direct action or by submitting draft resolutions to the General Conference (CGPM).

At a meeting held in Paris on 14 October 1999, the directors of the national metrology institutes (NMIs) of 38 Member States of BIPM and representatives of

2 international organizations signed a Mutual Recognition Arrangement (CIPM MRA) for national measurement standards and for the calibration and measurement certificates issued by NMIs. A number of other institutes have signed since then.

This Mutual Recognition Arrangement is in response to the growing need for an open, transparent, comprehensive scheme to give users reliable quantitative information on the comparability of national metrology services and to provide the technical basis for wider agreements negotiated for international trade, commerce, and regulatory affairs.

CIPM MRA has now been signed by the representatives of 76 institutes from 48 member states, 26 associates of CGPM, and 2 international organizations; it covers an additional 122 institutes designated by the signatory bodies (BIPM, 2002).

● OIML MAA

The purpose of the MAA is to introduce elements in the OIML Certificate System that can increase confidence in these Certificates, and to establish worldwide multilateral agreements, which offer a wider scope than bilateral or regional agreements.

Under the MAA, Declarations of Mutual Confidence (DoMCs) will be signed for categories of instruments in the OIML Certificate System.

By signing these DoMCs, participants will declare confidence in the test results issued by other participants. Participants will be of two kinds:

- Those who issue Test Reports (they will provide evidence of competence, impartiality and quality);
- Those who do not issue Test Reports under these conditions.

The MAA increases confidence in type examination testing in order to facilitate the use of OIML Evaluation Reports among participating economies and therefore avoid duplication of tests and examinations for manufacturers of measuring instruments.

The OIML MAA is based on an evaluation of the Testing Laboratories of OIML Issuing Authorities according to ISO/IEC 17025 General requirements for the competence of testing and calibration laboratories. Demonstrating conformity to ISO/IEC 17025 may be done either by an accreditation delivered by an accreditation body which is a full member of ILAC (ILAC MRA signatory) or by peer assessments managed by the OIML. In both cases, the evaluation is conducted in close cooperation between ILAC (International Laboratory Accreditation Cooperation) and the OIML.

The implementation of the OIML MAA started in 2005. Three Declarations of Mutual Confidence were signed at the beginning of the MAA implementation on load cells, nonautomatic weighing instruments and water meters. Currently, there are 22 participating economies including 11 Issuing Participants in the three DoMCs . A fourth DoMC was launched in July 2009 for automatic catchweighing instruments on the basis of OIML R 51.

In future, the OIML MAA may be implemented for other categories of measuring instruments that are included in the OIML Certificate System. Today, 41 categories of measuring instruments could potentially be covered by the OIML MAA. (reference: www. oiml.org)

● APEC TEL MRA

The APEC Mutual Recognition Arrangement for the Conformity Assessment of Telecommunications Equipment (APEC Tel MRA) was endorsed by the APEC Telecommunications and Information Industry Ministers in June 1998 and commenced in July 1999. In June 1998, the APEC Telecommunications and Information Ministers agreed to streamline APEC-wide processes for the testing and type approval of telecommunications equipment. As a landmark arrangement, the Mutual Recognition Arrangement for the Conformity Assessment of Telecommunications Equipment (APEC TEL MRA) was the world's first multilateral agreement of its kind. It is expected to eliminate a major barrier to what is forecast to be a USD 60 billion industry by 2010 (APEC, 1998). Its scope includes all equipment subject to telecommunication regulations including wireline and wireless and terrestrial and satellite equipment. For such equipment, MRA covers electromagnetic compatibility (EMC) and electrical safety aspects as well as purely telecommunications aspects of conformity assessment requirements.

This Arrangement is intended to streamline the Conformity Assessment Procedures for a wide range of telecommunications and telecommunications-related equipment, thereby facilitating trade among the Parties. It provides for mutual recognition by the importing parties of conformity assessment bodies and mutual acceptance of the results of testing and equipment certification procedures undertaken by those bodies in assessing the conformity of equipment to the importing Parties' own Technical Regulations. APEC economies are striving to follow the APEC Guidelines for the Regional Harmonization of Equipment Certification with the end in view of facilitating trade in telecommunications goods and services.

Questions and Discussions

1) How do we categorize conformity certification? Discuss the main activities in conformity assessment.
2) Explain further the following terminology by citing examples: conformity assessment, certification, accreditation, testing, first-party conformity assessment, second-party conformity assessment, and third conformity assessment.
3) Discuss the differences between quality management system certification and product certification.
4) Discuss the main standards in the ISO 9000 family of standards and QMS.
5) Discuss the main standards in the ISO 14000 family of standards and EMS.
6) Discuss the procedure for on-site audits for QMS/EMS certification.
7) Discuss the relationship between ISO 9001 certification and ISO 14001 certification.
8) Discuss the role of product certification and the difference between compulsory certification and voluntary certification by citing some famous marks.

9) What are WTO/TBT Agreements? Discuss the relationship between TBT and conformity assessment by giving examples.
10) What are MLAs/MRAs? Explain how MLAs/MRAs affect international trade by citing an example.

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Asia-Pacific
Economic Cooperation

Part II.
IMPACTS

Chapter 04

Economic Impacts – Macro Perspective

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Learning Objectives

After completing this chapter, you should be able to:

a) Understand the role of the standards and conformance infrastructure within a sustainable economy
b) Explain the mechanisms through which standards and conformance can affect economic growth and how they might be measured
c) Understand the impacts of standards and conformance on international trade
d) Explain the strategies that might be employed to resolve barriers to international trade created by standards and conformance measures

4.1 Definition of the Macro-Perspective

This Chapter considers the impacts of standards from the macro-perspective. The macro-perspective deals with the economy-wide impacts of standardisation, both the effects of the standards system that is being applied internally to foster economic development and the use of standards and conformance in international trade.

When one seeks to asses the impacts of standardisation, it is not adequate to restrict consideration to documentary technical standards. Metrology and conformity assessment are equally important examples of applying a systematic, standardised approach to the respective disciplines. These elements collectively make up what is sometimes called the standards and conformance infrastructure or the Standards Quality, Accreditation and Metrology (SQAM) system of an economy. The elements comprise:

a) Standards and Technical Regulations
b) Scientific, Industrial and Legal Metrology
c) Accreditation of bodies undertaking product and management system certification
d) Laboratory Accreditation

It is the interaction of these elements, coupled with their effectiveness, that will dictate the impact of the standards and conformance infrastructure on economic outcomes. However, the precise mechanism by which technical infrastructure influences economic development and productivity is not always readily apparent. It is often expressed in the negative, by saying that the technical infrastructure acts to prevent market failure. The question is how to measure the effect of something that acts in the background, so that a reasonably accurate economic model can be developed.

This Chapter does not attempt to consider the impact of private or company standards that are not publicly available. Such standards sit outside of the standards and conformance infrastructure of the economy and are generally beyond the scope of the published studies. However, such standards are considered in chapter 8 in the context of developing business strategies.

4.2 Analysis framework of economic effects of national standards and conformance infrastructure

4.2.1 Review of principal studies

Because overall economic development tends to progress in parallel with the increasing sophistication of the technical infrastructure, its contribution economic growth is not easily differentiated from other factors. Those who have attempted to quantify national economic benefits have thus needed to postulate a mechanism by which standards stimulate the economy.

This has been the path taken by a number of leading studies of the macro economic impacts of standards, including—

a) “The empirical economics of standards” (2005) DTI economics paper No. 12, London.

b) DIN "Economic benefits of standardization. Summary of results. Final report and practical examples." (2000) DIN, Berlin.
c) Blind, Knut (2004) "The Economics of Standards; Theory, Evidence, Policy" Edward Elgar Publishing, Northampton MA USA.
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f) "Standards, 'offshoring' and air transport" (2005) World Trade Organization (WTO) Geneva.
g) Paul David, "Some New Standards for the Economics of Standardization in the Information Age".
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i) Gregory Tassey, "Standardization in Technology-Based Markets," Research Policy".
j) John Scott and Stephen Martin, "The nature of innovation market failures and the design of public support for private innovation".

These studies provide a valuable corpus of thought about the quantitative economic contribution to various economies delivered by standards and conformance; but they must also be treated with appropriate caution for several reasons. Firstly, the studies are primarily European in origin and the European experience does not always readily translate into the APEC region, especially into the developing economy experience. Secondly, they tend to look at documentary standards in isolation from conformance, without considering the interaction between standards and conformance. Thirdly, there is a significant involvement of the National Standards Body (NSB) in many of these studies; and it is in the NSB's interest that the information and examples they provide to the study show the NSB's activities in a positive light and justify future government endorsement.

The basis of the estimates of the contribution to the national economy in all but the WTO study revolves around the premise that standards are a significant enabler of innovation and facilitator of technological change. This is very much an engineer's view of the role of standards in a well-functioning developed economy. It is also somewhat controversial, given the frequently expressed view within sections of industry that standards can also stifle innovation and hinder technological change. The role of standards in innovation is discussed in more detail in Chapter 7.

Some studies are more focussed on the benefits of standardisation to national economic growth realised through the contribution to innovation and technological change; whereas other studies are focussed on the more fundamental aspect of preventing market failure, the impact of which is harder to measure at the macro level; and therefore, will be studied in detail in the micro-economic context in Chapter 5. Both aspects need to be considered in order to get the full picture of the impact of standardisation, as explained by Swann v.

4.2.2 The quantum of economic benefit derived from innovation and technological change

The DIN study was based on the use of surveys and interviews with experts. Over 4,000 companies were selected at random and sent a printed questionnaire. The response rate was over 17%, giving 707 completed questionnaires for evaluation. The questionnaire contained 49 questions about the impact of standards on business, covering more than 340 details.

DIN concluded that ‘our study shows the economic benefits of standardization as being about 1% of the gross national product (1998: DM 31.5 billion). However, the assessment by an earlier study that the benefits of standardization were 1% of business sales must be corrected downwards. The positive macroeconomic effects, which far exceed the sum of individual benefits for the economy, and the relief of the state through technical standards, justify public financial support for standards work and give standardization a firm place in economic policy and research and innovation policies. In particular, the latter should take a more integral approach, taking full account of the relationship between innovation and its diffusion by means of standards.’

On the other hand, the 2005 UK study by the DTI was based firmly on economic modelling, breaking down growth in the British economy into its component contributing factors and then assessing the impact of standards as a contributor to technological change. It included a much more rigorous analysis of economic data and was critical of the DIN study for its reliance on opinion obtained through surveys, rather than using actual economic data.

The DTI study found that ‘the numbers suggest that standards are associated with growth in labour productivity of 0.28% per annum, or about 13% of the recorded growth in productivity over the period 1948-2002. This particular estimate can be recast into sources of overall growth of output in the UK. Our estimates of the overall impact of technological change is about 1.0% per annum over the same period – set against a growth rate of output in the whole economy (GDP) of 2.5%. The contribution of standards to technological change is over 25%.’ The overall conclusion is that standards make an annual contribution of GBP 2.5 billion to the UK economy’.

A 2007 study undertaken for the Standards Council of Canada was based on the research methodology that was originally used in the German study (DIN 2000) and the economic models in the UK study (DTI 2005).

The study involved four components: a review of the standards-oriented economics literature; an empirical analysis of the impact of the Canadian collection of standards on Canadian labour productivity; a series of interviews with senior executives from the private and public sectors; and an in-depth examination of the benefits of specific aspects of standardization in two Canadian companies.

The Canadian study found that ‘the empirical analysis clearly showed that standards play an important role in enhancing labour productivity, measured as output per hour worked. Over the study period of 1981-2004, standardization accounted for 17 per cent of the growth rate in labour productivity which translates into approximately 9 per cent of the growth rate in output (real GDP). The impact, over time, of this positive contribution to output growth is substantial. In 2004, the level of economic output (real GDP) would be expected to be $62 billion lower if there had been no growth in standards over the 1981-2004 period.'

A 2006 study undertaken on behalf of Standards Australia applied local economic data to the models developed in earlier studies in Europe. It found that 'over the 40 years to 2002, a 1 percent increase in the number of Australian Standards is associated with a 0.17 per cent increase in productivity across the economy. Additionally, standards can be considered, together with R&D expenditure, as contributing factors to the stock of knowledge, and the study finds that a 1 per cent increase in this joint stock of knowledge leads to a 0.12 per cent increase in economy-wide productivity.'

4.2.3 The more standards the better?

These national studies observe that there is a direct relationship between the increasing number of national standards and enhanced labour productivity. The DTI study bases this on the 'Standards Catalogue Index' (SCI). This is a measure of the contribution of publicly available standards by counting the number of standards appearing in the catalogue of the relevant NSB at a particular time. More specifically, this is measured at any point in time by:

Where:

$$SCI(t) \equiv \sum_{i=t-\infty}^{i=t} P(i) - \sum_{i=t-\infty}^{i=t} W(i)$$

SCI = standards catalogue index
P(i) = the number of standards published in any year i
W(i) = the number of standards withdrawn (or retired) in year i

Thus, SCI is simply the accumulation of all publications up to year t less all withdrawals over the same period.

The proposition that the more standards, the greater the national economic benefit, tends to ignore a few fundamental issues. Firstly, there are issues with the methodology of the calculation, because SCI is only based on the number of standards published by the NSB, when we know that there are typically at least as many publicly available standards and technical regulations developed outside of the NSB, as within it, for example those for healthcare, the Internet and medicine.

Secondly, the reach of individual national standards is non-uniform. For Standards Australia, in 2003, roughly 10 percent of the standards it published accounted for 90 percent of copies distributed. While this sort of data is not readily available from NSBs, the indications are that this is fairly typical for an NSB with a comprehensive catalogue of standards.

Thirdly, it is a bold assumption to suggest that the impact of each standard is more or less equal. How can one equate the contribution of a standard like ISO 9001, or one aimed at the principal national industry, with that of a standard aimed at a relatively obscure industry?

The DTI report quotes an excerpt from the first meeting of the Engineering Standards Committee, a forerunner of BSI. 'The variety of sizes of structural steel sections was reduced from 175 to 113 and the number of gauges of tramway rails was reduced from 75 to 5', bringing 'estimated savings in steel production costs of £1 million a year'. This certainly indicates the large benefits to be derived from targeting the most obvious areas in need of standardisation in the early period of an NSB's operation. However, the DTI report is silent on whether the same opportunities for savings of this magnitude continue to be delivered by new British Standards published in the current year.

Another way of looking at the UK example is that a standard which responds to a significant and well-defined problem in the market will have a disproportionately large economic impact. Intuitively, one would suspect that the law of diminishing returns applies to the impact of standards as the more critical needs are filled and attention turns to less pressing problems. This proposition is discussed again in Chapter 5.

It seems more likely that there is an optimum number of public standards necessary to gain the maximum economic benefit at any given point in time and stage of economic development within an economy. The WTO Report found that 'The demand for standardization services increases with the level of prevailing scientific, technical and business capacity, the level of industrialization, the degree of economic diversity, the importance of export markets, and the evolution of domestic consumer needs. It also depends on economy specific factors such as economy size, the form of industrialization, the degree of concentration of industrial sectors, and prevailing administrative and political structures and cultural norms'.

Rather than increased standards production driving improvements in labour productivity, it appears to be a case of standards production needing to keep pace with economic growth and technological change to support those developments.

The final word on the subject should perhaps come from the 1995 Kean Report in Australia. The report admonished Standards Australia for it's cosy relationship with its highly profitable certification subsidiary, citing industry concerns that the NSB was producing unnecessary new standards simply to create business opportunities for certification. This accusation was strongly refuted by the NSB at the time; but in late 2003, Standards Australia finally made the separation proposed by Kean and sold off its commercial activities.

It appears that, with the income stream from the certification business and other commercial activities now safely converted into capital, the NSB became free to take a more objective view of the optimum number of standards needed to support national economic activity. Standards Australia has introduced a much more rigorous national benefit test to proposals for new standards and the figures for 2009 show that the number of standards published has reduced to less than 300 per year, down from over 500 in 2003. There is no evidence of this reduction leading to a consequential downturn in national labour productivity.

4.2.4 The halo effect

The halo effect occurs when an external standards and conformance regime, beyond an economy's borders, has an impact on the internal standards and conformance regime within the economy. For example, if the principal world manufacturers of a product are aiming to achieve entry into a very large overseas market, perhaps the European Union, then it may be that virtually all export product on the international market complies with the extensive standards and conformity assessment regime for products required under the European Directives. In addition, export-oriented manufacturers within the local economy may be similarly targeting that large external market and applying European standards with European third-party conformity assessment to all product they make.

As a result, there may be no need to establish a local standard or a local conformity assessment regime within the economy in order to prevent market failure. The halo effect from the larger market has already ensured that all product coming onto the smaller local market will meet, or even exceed, local expectations of quality, safety and fitness for purpose.

4.2.5 Summary of impacts at the macro level

The most significant macro impacts of the standards and conformance infrastructure on an economy derive from underpinning innovation and technological change, as well as from building confidence in the market by preventing instances of market failure. These impacts are difficult to objectively measure and quantify at the macro level because there are so many complicating factors; although many have tried using a range of methodologies, as discussed, generally with a specific purpose in mind. The true magnitude of the total contribution only tends to become readily apparent in the national economy when the infrastructure is deficient to the point where instances of market failure become widespread.

What can be said with confidence is that an economy will be constrained in growth and development by deficiencies in the standards and conformance infrastructure, particularly if it fails to keep pace with the current state of economic and industrial advancement.

There is no one perfect model for a national standards and conformance infrastructure; and what is right at one point in time may need to evolve to a different structure as the economy develops. It simply needs to be compatible with the domestic system of government and be capable of meshing well with other institutions in the economy.

4.3 Standards and sustainable trade

The earlier part of this Chapter dealt with the impacts of standards on the functioning of the internal market within an economy; however, the impacts of standardisation on cross border trade are potentially even more significant.

4.3.1 Sustainable trade

The expression ‘sustainable trade’ in this context refers to economically sustainability, rather than social or environmental sustainability. In other words, those factors that make international trade a reliable source of products and services for the importer and a dependable source of income for exporters. Trade can become unsustainable for a range of reasons, for example because it is one direction only, leading to debt issues, but the analysis here will consider only those aspects of sustainability amenable to influence by standards and conformance.

4.3.2 Economic models

There are a number of economic models for the way in which technical regulations, standards and related conformity assessment procedures affect international trade. Perhaps the leading authority is Ganslandt and Markusen, who found that 'Standards and technical regulations which govern the admissibility of imported goods into an economy raise costs of exporters entering new markets, and may have a particularly high impact on firms seeking to export from developing economies.'

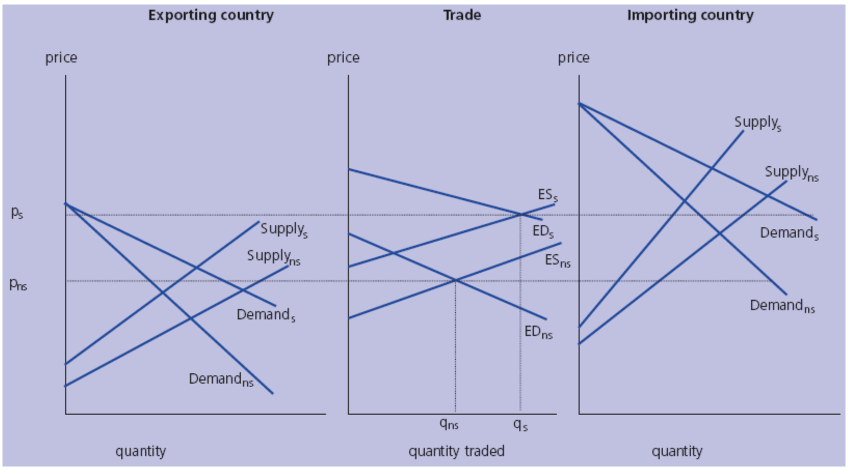
The following explanation from the 2005 WTO Report highlights the typical approach taken to economic modelling of the impact of standards on international trade.

'To investigate the ambiguity of the effect of a product standard on trade and welfare, consider a two economy situation in which there are many consumers and many firms in each, i.e., there is perfect competition, except that the assumption of perfect information is not met for consumers. The product is assumed to have a credence characteristic. The possibility that it might be optimal for the government in each economy to exploit its international market power is ignored. Prior to imposition of the product standard by the importing economy, the equilibrium world price (*pns*) is found in the middle panel where the export supply function (ES_{ns}) and the import demand (ED_{ns}) function intersect (see Figure 4.1).

'These functions are derived from the domestic demand and supply functions for the exporting economy (left-hand panel) and the importing economy (right-hand), respectively. The volume of the product traded is *qns* and the welfare gains from trade for both economies jointly, measured from no trade, is given in the middle panel by the area of the triangle bounded by the price axis, and the ED_{ns} and ES_{ns} functions. The area below the price line (*pns*) and above the *ESns* line is the gain to the exporting economy; and the area above the price line and below the ED_{ns} line is the gain to the importing economy.

'To overcome the market failure caused by lack of information about the quality of this product, suppose that the government in the importing economy imposes a standard which has to be complied with by both domestic and export suppliers. There are two consequences in the importing economy: production costs are likely to rise and consumers will gain greater utility from consuming the good. These effects are illustrated in the right-hand panel by the upward shift in the supply function and the rotation of the demand function, respectively. Together, these changes alter the position of the import demand function from ED_{ns} to ED_s. In the exporting economy, production costs will also rise, at least in producing the product for export.

'Consumers in the exporting economy may or may not hold the same preferences as those in the importing economy and, therefore, there may or may not be a rotation in the domestic demand function. In Figure 4.1 it is assumed that costs rise for all production and that consumers prefer the higher standard.



◀Figure 4-1 The Effect of Standards on Trade Volumes

'The effect of the standard on trade and welfare are shown in the middle panel. Given the assumptions made about cost increases and consumers' utility, there is an increase in the volume of trade, an increase in welfare for each economy and for this two-economy world. However, it is straightforward to show that this is not the only possible outcome. By altering the assumptions and reflecting these in the relative shifts of the trade functions, it is possible to show that the exporting economy can lose welfare from the imposition of the standard by the importing economy and that world welfare could still rise.

'But it is also possible to show that there is no monotonic relationship between the direction of change in the volume of trade and that of welfare for the exporting economy or for world welfare: the volume of trade could increase and yet world welfare could fall. It can be assumed that the welfare of the importing economy will not fall because a rational government would not impose a welfare-reducing standard in order to correct a market failure.'

The limitation on this simplistic type of analysis is that it looks at the input costs due to standards compliance in isolation from other input costs when that may not be the dominant variable between the trading partners.

4.3.3 Offshore manufacturing

The concept of manufactured goods originating from a specific economy is much less clear than it once was. What labels like 'made in Republic of XXXX' really means is certainly a question that has many different answers; and it's a subject that is tackled many different ways when one looks at economy of origin labelling laws around the world where a variety of definitions are used.

Offshore manufacturing began in an environment of high tariffs, responding to different drivers compared to how it operates today. The automobile industry recognised in the early 1980's that it made sense to work towards the 'world car' concept to enhance efficiency. In other words, the components parts would each be made in a different subsidiary plant, for example, engines in Australia, transmissions in Germany, electrical systems in Belgium, etc; and then the final car would often be assembled in the economy of destination. This allowed for a degree of specialisation and efficiency due to the volume of production at each plant around the world; but it also meant that tariff thresholds based on the percentage of local content could be reached as a result of the high cost of the labour needed to undertake the final assembly. In an engineering sense, this could only ever work well with excellent quality control and strict adherence to the company's internal standards to ensure compatibility of parts made in different parts of the world.

In more recent times, with reduced tariff barriers, manufacturing industries in wealthier economies have made a wholesale move to relocate their operations to offshore locations with lower labour costs. While brand names may be from a developed economy, the point of manufacture is frequently in a developing economy.

For example, the makers of a leading Australian brand of industrial footwear have embraced this trend. The uppers and soles of the footwear are now made in India and then joined together in Australia. Disparity in labour rates mean that the costs of the single process undertaken in Australia far outweigh those in India, even though most of the manufacturing steps take place in India. The footwear can, however, legally be labelled as 'made in Australia' because the essential character of the product as boots was established in Australia and more than half of the input costs in their manufacture was expended in Australia.

Of course, in many cases it is simply the brand name that is important to the customer and most running shoes are made in Asia and labelled accordingly, despite having brands associated with the US or Europe.

From a standards and conformance point of view, the economy of manufacture is less important than the economy where the product is destined to be sold. Compliance with the technical regulations of the economy of manufacture will not be legally required for products destined exclusively for export. However, the technical regulations where the product is to be sold will definitely be applied.

Offshore manufacturing presents additional challenges to maintaining compliance, especially if the local culture at the point of manufacture is more price-driven and the emphasis on managing quality to high levels is viewed as wastefully excessive. As well, it may sometimes be more difficult to rely on the consistency of components and raw materials from local suppliers. The companies that have successfully made the transition to offshore manufacturing have generally been those that have been able to fully implement the quality management regimes and standards of the parent company at their offshore manufacturing plants.

4.3.4 The evolution of technical barriers to trade

It would be a mistake to pretend that international markets are close to perfect or that standards-based non-tariff barriers to trade do not exist. As tariff barriers have come down, the true extent of non-tariff barriers to trade have been revealed more starkly.

There is both a political and a human dimension to the creation of technical barriers to trade that often defy rational economic theory. The first point to note is that, in the real world, local technical regulations are rarely, if ever, created with a view to their trade impacts. They tend to developed through an inwardly focussed process in order to respond to a local and immediate problem of market failure.

The two economies in the above example may have identical aspirations in terms of the welfare of their citizens, let’s say reducing head injuries due to bicycle accidents, but that doesn’t mean that they will apply the same technical regulatory solution. They may both respond to the problem by introducing new national standards for bicycle helmets. Like many aspects of product safety, the science of measuring the effectiveness of a bicycle helmet is still evolving. As a result, the two national standards will almost certainly end up employing different methods to measure impact energy absorption and resistance to penetration, based on a diversity of expert opinions from local researchers who study bicycle accidents.

Some years later, the opportunity arises to trade in these, now widely used, pieces of safety equipment; but it’s discovered that there is a technical barrier blocking the way as a result of the dissimilar standards.

From the point of view of their respective governments, both economies have an effective standards solution to an emotive safety problem that has been developed in consultation with their local experts and is working well. Head injuries are greatly reduced in both economies, so why upset this arrangement? What is more, the local industry in each economy has spent considerable money in developing products to comply with the local standard and raises concerns about potential for market entry by ‘foreign imports that don’t meet our safety standards’. Again, good reason for government to maintain the status quo.

The actual helmets being made in each economy may not be very different in design and construction, despite the standard in economy A having a slightly higher requirement for impact energy absorption and a slightly lower requirement for penetration resistance, compared to the standard applying in economy B. It could be that 80% of the products currently being made in economy A would meet the standard used in economy B, without having to be modified, and vice-versa. However, even though in most cases the standard could be met without the need for redesign, the additional costs of retesting and certification in a second economy would put exporters at a considerable price disadvantage. The cost of demonstrating compliance and the associated delays in getting to market caused by having products reassessed normally outweigh the costs associated with redesign.

This is a typical example of how a non-tariff barrier to trade quite innocently comes into existence through the use of standards and conformance to prevent a local market failure. It fairly accurately describes the reason why Europe and North America have evolved to have two very different and largely incompatible standards and conformance systems, even though the disposable incomes and expectations of product safety and performance of their citizens are apparently so similar. Once these barriers become entrenched, they are very difficult to dismantle, despite the apparent rationality of doing so.

4.3.5 Approaches to resolving trade barriers

There are three ways for trading economies to reconcile a standards-based non-tariff barrier to trade:

a) **Option 1**: **Market dominance** Economy A could set aside its own national standard and accept that of economy B. This typically happens when economy B possesses substantially greater power in the international market than economy A.

b) **Option 2**: **Shared standards** The two economies could agree to jointly develop a common or shared standard with compromises on requirements by both sides. The evolution of Australian/New Zealand standards is an example of this in practice on a bilateral basis and European Standards (ENs) represent a plurilateral example.

c) **Option 3**: **Mutual recognition** The two economies could enter into a mutual recognition agreement whereby, even though their standards are incompatible, if a product can legally be sold in economy A, it is granted automatic market entry into economy B without further assessment, and vice versa. This mechanism requires a high level of confidence and trust between the two economies.

In practice, Option 3, mutual recognition, is the approach that is least often adopted, even though it is the one that is most widely recommended. As noted, it requires a high level of trust, such as might exist within a common economic zone. In effect, mutual recognition has the effect of recognising two or more different standards as being deemed to satisfy the local technical regulation in each economy. However, industry will soon discover which of these standards gives a marketplace advantage, either through requirements that are more easily met, lower conformity assessment costs, greater flexibility or some other benefit. That standard will effectively become the new minimum set of requirements for market entry and the other national standards will become redundant.

In the case of Australia and New Zealand, the Trans-Tasman Mutual Recognition Agreement was an example of Option 3; however for the practical reasons outlined, over time, the vast majority of standards supporting product-specific technical regulations have either migrated across to Option 2 to become joint Australian/New Zealand Standards; or alternatively, the class of products has been exempted from mutual recognition.

Option 1 is widely used, particularly when a third economy is seeking to trade with one of the two dominant trade blocs in the world today, the European Union and North America. This approach certainly leads to some rationalisation of standards used in trade. The dilemma, of course, is that when seeking market entry to both of these trading blocs, a third economy is still faced with having to make products compliant with two different and incompatible sets of standards.

Option 2 works best where there is some form of overarching legal framework agreed between the sovereign entities who are seeking to trade. In the case of the European Union that framework is provided by the Treaty of Maastricht and its subsidiary agreements, which in turn have led to the establishment of the various Directorates charged with developing the European Directives, which are basically model technical regulations. Within APEC, there are also many examples, including the ASEAN Free Trade Area (AFTA), the North American Free Trade Agreement (NAFTA) and various other free trade agreements.

Apart from these bilateral and plurilateral arrangements, there are two subsidiary agreements under the World Trade Organisation (WTO) which can provide the necessary legal framework at the international level for the application of shared standards. We know this type of shared standard as an international standard.

4.3.6 WTO Agreements and international standards

There are a variety of subsidiary agreements under the WTO that its members may choose to join, for example, the General Agreement on Trade in Services (GATS). However, not all WTO members subscribe to all WTO subsidiary agreements.

There are two such agreements that make specific reference to standards and conformance: the Agreement on Technical Barriers to Trade (TBT) and the Agreement on the Application of Sanitary and Phytosanitary Measures (SPS). These two agreements and the committees established under them to arbitrate on disputes have provided a sound foundation for good technical regulatory practices around the world, for example the *APEC Information Notes on Good Practice for Technical Regulation*.

The TBT and SPS agreements identify the use of international standards as the universal benchmark for non-trade-restrictive technical regulations. If members adopt technical regulations that differ from relevant international standards, they may be challenged to justify their reasons for doing so and there are several defences. While both the TBT and SPS include mechanisms to assist developing economies in the transition of their technical infrastructures towards international alignment, any relaxation of requirements is only intended to be a temporary measure.

4.3.7 TBT Agreement

The current TBT agreement came out of the Uruguay Round of trade negotiations and builds upon the 1994 GATT agreement. It is directed towards trade in goods, other than those covered by the SPS agreement. In practice that means non-food manufactured goods. The TBT Agreement also encompasses provisions for conformity assessment and packaging and labelling.

According to Article 2.2 of the TBT Agreement:

> *Members shall ensure that technical regulations are not prepared, adopted or applied with a view to or with the effect of creating unnecessary obstacles to international trade. For this purpose, technical regulations shall not be more trade-restrictive than necessary to fulfil a legitimate objective, taking account of the risks non-fulfilment would create. Such legitimate objectives are, inter alia: national security requirements; the prevention of deceptive practices; protection of human health or safety, animal or plant life or*

health, or the environment. In assessing such risks, relevant elements of consideration are, inter alia: available scientific and technical information, related processing technology or intended end-uses of products.

Article 2.4 states:

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 except when such international standards or relevant parts would be an ineffective or inappropriate means for the fulfilment of the legitimate objectives pursued, for instance because of fundamental climatic or geographical factors or fundamental technological problems.

Article 2.5 further states that:

A Member preparing, adopting or applying a technical regulation which may have a significant effect on trade of other Members shall, upon the request of another Member, explain the justification for that technical regulation in terms of the provisions of paragraphs 2 to 4. Whenever a technical regulation is prepared, adopted or applied for one of the legitimate objectives explicitly mentioned in paragraph 2, and is in accordance with relevant international standards, it shall be rebuttably presumed not to create an unnecessary obstacle to international trade.

Originally, the use of the expression 'international standards' in the TBT Agreement was understood to mean those standards published by the International Organization for Standardization (ISO), the International Electrotechnical Committee (IEC) and the International Telecommunications Union (ITU). However in 2002, the WTO published a decision of the TBT Committee arising from the second triennial review of the Agreement that specifically dealt with 'international standards' as mentioned in the Articles quoted above. The preamble to the decision stated that:

Adverse trade effects might arise from standards emanating from international bodies as defined in the agreement which had no procedures for soliciting input from a wide range of interests. Bodies operating with open, impartial and transparent procedures, that afforded an opportunity for consensus among all interested parties in the territories of at least all Members, were seen as more likely to develop standard which were effective and relevant on a global basis and would thereby contribute to the goal of the Agreement to prevent unnecessary obstacles to trade.

The decision effectively recognised that ISO and IEC, in particular, were not always the bodies best placed to deliver a standard that was *globally relevant*; in other words, a standard that fairly reflected the consensus of views of the bulk of interested parties around the world. The TBT Committee therefore changed the definition of an *international standard* to be the deliverable of any international standardising body that could meet a set of principles contained in the decision.

This was a positive result and allowed standards developed through international consortia, particularly in the IT industry, to be recognised. The decision also made the defence that a trade restrictive technical regulation was based on an ISO or IEC standard, contestable on the grounds that the particular international standard did not meet the criteria in the decision.

The genesis of this decision was, at least in part, the fact that ISO and IEC use two-thirds majority voting in ballots with one vote per national member body. Decision-making on national lines can easily frustrate the process of seeking a fair compromise between the interests of, say, consumers and suppliers, that is normally the basis of national standards-development processes. In addition, within ISO and IEC, the vote of the USA with 400 million potentially interested parties is counted as being equal to that of, say, Belgium with only 10 million potentially interested parties. The ambiguity in the voting system came into sharp focus with the signing of the Vienna Agreement (between ISO and CEN) and the Lugarno Agreement (between IEC and CENELEC) which provided a framework for joint working between the relevant European and international standards bodies on selected projects.

In practice, these agreements coupled with the voting system have resulted in the work programs of about one-third of the technical committees of ISO and IEC becoming directed exclusively towards developing norms to fulfil European Commission mandates, with the resultant standards being jointly identified as European and International Standards, even though they are skewed towards meeting European regulatory needs and enshrining European practices. Clearly, such an International Standard did not meet the intent of the TBT Agreement which sought to promote the development and use of globally relevant shared standards, agreed at a minimum, between the two major world trading blocs.

A further positive result of the TBT decision was that many national standards development organisations have now opened up membership of their technical committees to the participation of representatives nominated by foreign national standards bodies, in an endeavour to meet the 'international standard' test in the decision. While not all standards produced this way would meet the test, the move has promoted greater transparency in national standards development.

Of course, a great many of the standards published by ISO and IEC would meet the global relevance tests contained in the decision. These two international organisations have been particularly effective in developing globally relevant international standards in fields where there were no existing, well-entrenched national or regional standards. In that case, both Europe and North America can come to ISO or IEC table with a clean slate, unencumbered by the need to defend the status quo. Thus it is that new technologies tend to be better served by shared international standards compared to older technologies. For example, the ISO/IEC standards on Information Technology are used world wide.

Global relevance is not just an issue between developed economies, quite often ISO and IEC standards are set at a level beyond the means of people in developing economies. They sometimes cite test methods based on equipment that is not generally affordable, other than in a few of the wealthiest economies, or they may make assumptions about customers' expectations of performance and ability to pay that are not relevant to developing economies. This issue has been well-documented in ISO/DEVCO, the developing economies consultative committee within ISO, but it is a difficult issue to resolve.

4.3.8 Containerisation – a standards success story

There are a small number of international standards that have been instrumental in facilitating a major change in behaviour in the world's economies and deserve to be considered as delivering macro-economic impacts. Management systems and electronic data standards are often cited in this regard; however, the containerisation of the transport of goods is perhaps one of best examples.

Up until the 1950's goods were either transported in bulk or else were packed into hessian bags or wooden crates of various sizes for shipping. Packing these mixed loads of crates into the holds of ships was a time-consuming manual exercise that meant extended demurrage for ships at either end of their voyage.

The idea of having a system of unitised shipping containers had been around for some time; but it was only during World War II that standardised containers were first used in significant numbers for military applications. Different systems began to come into use in non-military applications during the 1950's; but each had its own dimensions and getting international agreement on the dimensions was the sticking point.

In 1968, ISO published a ground-breaking standard, ISO R668, that set the dimensions of shipping containers as 8'0" wide x 8'6" high x 20'0" long[1)], which can be extended to 40'. This allows for 4' x 4' pallets to be stacked two abreast and two high within the container.

In 2005, it was estimated that around the world some 18 million ISO compliant containers make over 200 million trips each year, accounting for over 90% of non-bulk freight. The size of a shipping container sets the dimensions for every aspect of logistics: the maximum width of vehicles and the width of roads, the heights of tunnels, both road and rail, the design of ships and the design of handling equipment to load and unload them. Truly, a standard with economy-wide ramifications.

4.3.9 Conformity assessment and trade

Assuming that the standards have been aligned between trading partners, there is still a potential trade barrier resulting from differences in conformity assessment arrangements. Conformity assessment requirements for regulated products may involve a range of different approaches according to the risk of nonconformity and the hazard posed by a non-conforming product. The conformity assessment modules annexed to each of the European Directives provide an overview of the range of different measures that might be used. The more onerous the requirements, the greater the cost.

As a complement to the EC's New Approach, the "Global Approach to Testing

1)) The reason this was expressed in feet and inches is that, at the time, many of the economies that have now adopted metric measures were still using the imperial system. In the US, there is now also a 48' long container.

and Certification" and its "CE" mark ("Conformité Européenne"), were created to ensure conformity of a product with applicable Directive(s). Directives contain "essential requirements" to be achieved in terms of product safety, etc., but do not stipulate the technical solutions for attaining them. Those are specified by European harmonized standards whose adoption is voluntary, but products meeting these standards automatically benefit from a presumption of conformity with the essential requirements set out in the Directive. Products covered by one of the Directives must bear the CE mark to gain marketing approval. Manufacturers may choose among eight conformity assessment activities ("modules") to demonstrate compliance.

Each Directive specifies which module or combination of modules is admissible, which may vary in relation to the perceived risks of the covered products. The modules are "Internal production control" (Module A), "EC type-examination" (Module B), "Unit verification" (Module G) and "Full quality assurance" (Module H), of which modules A, G and H refer to attestations that both the design of a product and produced units conform to the provisions of the applicable Directive. Module B refers to design only and may be combined with one of four modules referring to production: "Conformity to type" (Module C), "Production quality assurance" (Module D), "Product quality assurance" (Module E) and "Product verification" (Module F). Modules D, E and F, while normally used in combination with module B, may in special cases (for example, when dealing with certain products of very simple design and construction) be used on their own (European Commission, 1993a). The extent to which EC-accredited conformity assessment bodies, so-called "notified bodies" that have the exclusive right to award the CE mark, must be involved varies between the modules.

Addressing the 2005 OECD Workshop and Policy Dialogue on Standards and Conformity Assessment in Trade: Minimising Barriers And Maximising Benefits, Mr. Shinji Fujino[2), , stated that 'speaking from the viewpoint of trade facilitation, differences in technical regulations will not be serious barriers to trade as long as effective conformity assessment mechanisms are available. In other words, our main problem will not be whether deviations exist or not, but how to overcome such deviations smoothly and efficiently through conformity assessment procedures.'

Again, there are three ways for trading economies to deal with this type of non-tariff barrier:

Option 1: Market dominance

Economy A participates in the conformity assessment processes of economy B, at least for export products.

Option 2: Accept a common conformity assessment regime

The two economies could agree to both accept a common conformity assessment system operated by a third party, for example the IEC EE CB scheme.

2) Director, International Affairs Office Of The Technical Regulations, Standards And Conformity Assessment Policy Department, METI and Deputy Secretary General of the Japan Industrial Standards Committee

Option 3: Mutual recognition

The two economies could enter into a mutual recognition agreement whereby, if a product can legally be sold in economy A, it is granted automatic market entry into economy B without further assessment, and vice versa.

Mutual recognition is given prominence in the TBT Agreement. Article 6.3 states:

Members are encouraged, at the request of other Members, to be willing to enter into negotiations for the conclusion of agreements for the mutual recognition of results of each other's conformity assessment procedures. Members may require that such agreements fulfill the criteria of paragraph 1 and give mutual satisfaction regarding their potential for facilitating trade in the products concerned.

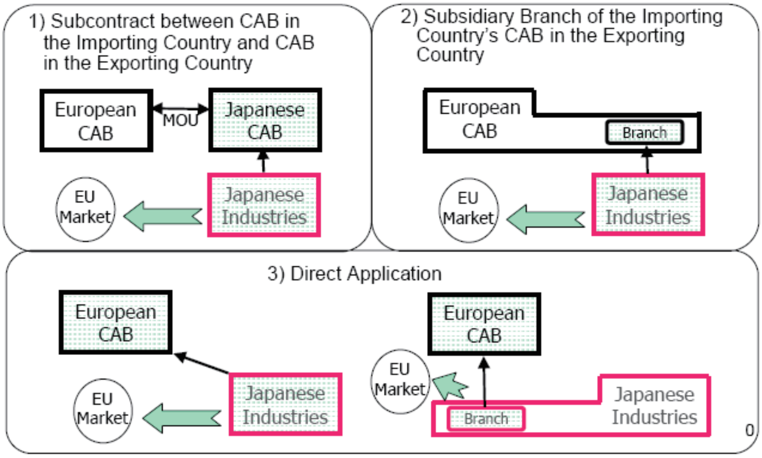
However, the reference to paragraph 1, which sets out a member's absolute right to protect the welfare of its citizens, is the key consideration. As explained earlier, the majority of technical barriers to trade were instituted to protect the welfare of citizens.

Option 3, mutual recognition, requires a high level of confidence and trust between the two economies. Should a defective bicycle helmet slip through the conformity assessment arrangements in economy A, and find its way to a consumer in economy B, it will be the safety regulator in economy B that will be criticised for overseeing a system of safety regulation that allowed this to happen. Even though the standards for household electrical and electronic equipment have been substantially aligned between APEC economies, there are only a handful of participants in Part 3 of the APEC EE MRA, which is the Part that involves full mutual recognition.

Option 2 is limited in its application by the lack of certification schemes not tied to a specific economy. Even in the case of the IEC EE CB scheme, it is generally employed to only cover the technical assessment of compliance, with additional conditions applied by the receiving economy.

In practice, for regulated products, Option 1, is the most common one used. At a technical level, there are extensive MRAs in place between the laboratory accreditation bodies of different economies through ILAC and APLAC that provide confidence in testing results; however, local regulators still normally require accountability for testing results to be borne by a conformity assessment body within the regulator's legal reach. This gives a measure of control through licensing, regulation and suspension; as well as seeking redress, should a problem arise.

At the 2005 OECD Workshop and Policy Dialogue, Mr Fujino provided an example (shown in Figure 4.2) of how this works in practice with Japanese electrical goods for export to Europe. In Example 1, the technical work of testing the products is carried out by a Japanese conformity assessment body acting as a subcontractor to a European conformity assessment body. In that case, both conformity assessment bodies would be members of the IEC EE CB scheme and could recognise each other's test certificates. However, as far the European regulatory agencies are concerned it is the European conformity assessment body that is wholly responsible. Alternatively, a subsidiary of the European conformity assessment body could set up business in Japan as per Example 2. The last option is for the Japanese company to simply send product to the European conformity assessment body for assessment, either direct from Japan or through a Japanese subsidiary company, based in Europe.



◀Figure 4-2 Examples of Conformity Assessment Approaches

4.3.10 SPS Agreement

Food is the most widely traded commodity in APEC and the size of that market is increasing. The value of world-wide trade in agricultural products has increased from US$ 852 billion in 2005 to US$ 1,127.7 billion in 2007, according to WTO (2006, 2008) statistics.

There is a separate WTO Agreement that operates in parallel with the TBT Agreement and covers food, pharmaceuticals and other products that can affect the health of humans, animals or plants. This known as the SPS Agreement. The key difference from the TBT Agreement is that, under the SPS Agreement, the defence against a claim that a technical regulation is unnecessarily trade restrictive has to be based on scientific evidence.

The question of which international standards are recognised under the SPS Agreement has never been in dispute. These are the standards of the *Codex Alimentarius* Commission, the International Office of Epizootics, and the international and regional organizations operating within the framework of the International Plant Protection Convention.

From time to time, developing economies have challenged the cost associated with the testing and the trials required in order to establish a new *Codex* standard for a product indigenous to a local region to allow it to be traded internationally. As with the TBT Agreement, the SPS agreement makes provision for flexibility to accommodate the limitations faced by developing economies and where there is a political will to accept a product, the absence of a *Codex* Standard is not necessarily a barrier.

There are often political factors that affect imports of agricultural and other food products to major world markets and it would be naive to say that non-tariff barriers do not exist in the SPS sector. Donna Roberts et al 'acknowledge the existence of regulatory capture, when domestic groups with a vested interest in limiting competition successfully lobby for technical measures having questionable legitimacy and that potentially represent a net cost to a economy'.

In 2009, Ceyhun Elci of London South Bank University, reviewed the impact on trade of national standards in the SPS sector and noted that they had a 'legitimate use by governments to protect consumers' health, to recognise citizen preferences in packaging and labelling, and protect the environment from the establishment of non-indigenous pests and food-borne diseases. However, to what extent is the question'.

In many cases, outbreaks of diseases have long-term implications for the sustainability of agriculture and food security, as with the likes of food-borne pathogens that have an aftermath economic impact, for example, BSE, Avian Influenza, Swine Flu and etc. In such cases, it is perfectly reasonable for national governments to err on the side of caution to protect their citizens.

However, Elci found that the SPS requirements are often distorted by 'measures such as extreme standards, manipulated scientific standards and biodiversity related national import or export controls or multi-lateral agreements, such as Geographical Indicators (GI) as stated in Part II (Articles 9-40), Section 3 of the TRIPS agreement for the Protection of Appellations of Origin which clearly is a trade-related measure impacting trade and biodiversity'. This last point refers to the agreement that restricts the use of terms like 'champagne' to produce from a certain geographical region.

While food remains a controversial area in terms of unnecessary technical barriers to trade, APEC has devoted considerable energy to addressing questions of food safety in its standards work program. This even extends to supporting industry initiatives in the Pacific region to resolve questions related to wine labelling.

4.3.11 Intergovernmental standards

There are numerous international conventions and treaties that national governments may sign onto setting out matters of principle which may eventually be given effect in national technical regulations. For example, the conventions of the International Labour Organisation (ILO) set out basic rights to reasonable working conditions in terms of how they would affect an employee; however, they are not written as technical regulations. These principles need to be translated into requirements employers must adhere to regarding the design and operation of workplaces if they are to be given effect through national technical regulations. Therefore, these types of conventions and treaties would not be considered 'standards' in the sense that the term is used in this Chapter.

However, not all intergovernmental activities in this field are of the same nature. In addition to the non-government standards development bodies, ISO and IEC, there are a number of other international bodies that provide an opportunity for governments to participate direct with each other to develop technical standards for international application. The *Codex Alimentarius* Commission is one example, but others include the International Maritime Organisation (IMO) which develops safety requirements for international shipping, the International Organisation for Legal Metrology (*Organisation Internationale de Métrologie Légale* - OIML) which develops requirements for pattern approval of measuring equipment used in legal metrology and the International Telecommunications Union (ITU) which produces global telecommunications standards.

The distinction here is that, where a standard is set by one of these bodies, the technical requirements are clearly set out to a level of detail where industry can directly apply the standard. For example, the Convention on the Safety of Life at Sea (SOLAS) under IMO sets out the type and number of lifesaving appliances a ship must carry according to the number of crew and passengers on board and the nature of the ship's operations.

The international standards derived through intergovernmental activities arguably have as much impact on economies as those developed by the private sector international standards bodies. Where it is clear that national technical regulations are to be introduced by all parties; and incompatibility of national technical requirements could have significant consequences for the world economy, governments are more likely to come together and take a direct role in international standards-setting.

Intergovernmental processes manage to avoid the numbers-driven decision making that limits ISO and IEC, perhaps because officials involved in the negotiations are cognisant of the broader international context and the importance of ensuring that major parties are comfortable with the final outcome. By contrast, ISO and IEC technical committees are largely the province of industry representatives who are often seeking to gain a commercial advantage over their international competitors with little thought given to on-going international relations.

However, one should not assume that intergovernmental standards will automatically provide shared standards between the signatories. There is still a second step required to give an intergovernmental standard legal force at the national level and local variations can be introduced at that stage. For example, the Convention on the International Regulations for Preventing Collisions at Sea (COLREGS) under IMO governs the performance of navigation lights on boats, but the US and Europe have still managed to introduce local differences into the product standards for those lights.

Perhaps the strongest argument against going down the intergovernmental path is the potential lack of industry engagement in the process that may lead to impractical requirements and resistance to implementation. This risk needs to be balanced against the potential benefits when considering such an approach.

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Chapter 05

Economic Impacts – Micro Perspective

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Learning Objectives

After completing this chapter, you should be able to:

a) Identify the need for a standards and conformance solution to a market failure
b) Assess the economic and social impacts of introducing a specific standard or conformance measure
c) Explain the role of prescription and outcome focussed strategies when designing standards and conformance measures

Opening case

An experience in Fiji provides a good example of the benefits flowing from a single standard that are self-evident without the need for econometric analysis.

The principal income sources for Fiji have traditionally been tourism and garment manufacture for export. Fiji is made up of a series of islands that are subject to severe tropical storms and holiday resorts tend to be built by overseas hotel chains to the building standards of the hotel chain's economy of origin, taking account of storm loadings. Similarly, garments are made to comply with the standards of export markets. As a result, for many years there was little need for local standards in an economy of only 850,000 persons.

A popular building method in Fiji, used by the local population, involves the use of metal sheeting as a roofing material. That sheeting, in turn, relies on the strength of roofing screws to keep it in place during storms. If the screws fail during a storm, there is not only damage to the property, but the flying metal sheets represent an extreme danger to persons.

Low quality roofing screws, unfit for their intended purpose, began appearing on the international market in the early 1980's and found their way to Fiji. The extent of the problem only became apparent when the tail end of a tropical cyclone impacted Fiji and there were multiple roofing failures. In the early 1990's, Fiji introduced its first national standard based on the ISO standard for roofing screws and mandated it as a condition of supply in an associated technical regulation. As a result, the problem of under-strength roofing screws was resolved.

In this case, one can't consider the costs associated with using the low quality screws as the baseline, because they didn't serve their intended function. The true baseline was the use of the ISO standard compliant screws which were always the only ones suitable for use to secure metal sheeting on a roof.

5.1 Definition of Micro-Perspective

This Chapter describes the impacts of standards and conformance from the micro-perspective. The micro-perspective is centred the impacts of individual standards and groups of standards on particular businesses and industry sectors. As in Chapter 4, the full range of standards and conformance measures will be considered, including both regulated and voluntary measures. The role of a standard as a means of resolving an aspect of market failure will be considered along with the social considerations that might indicate the need for a standard.

Econometrics are an important tool in this analysis, but this tool also has its limitations and a range of types of analysis will be considered.

5.2 Analysis Framework of Economic Effects from the Micro-Perspective

5.2.1 Identifying the problem

It isn't always clear why a specific standard was developed and exactly how it was meant to resolve a market failure. Often the problem to be resolved is set out in the Objective clause or in another preliminary element of the standard, such as the Preface. For example, 'The objective of this standard is to ensure that environmental claims are based on factual evidence and are not misleading'. While not every standard includes an objective statement within its content, a standard that was developed without a defined goal is unlikely to deliver an optimal, cost effective solution and will place unintended burdens on the community.

Sometimes, the standard does not address the problem as a whole, but may address certain elements of it. For instance, the problem may be a safety problem with a consumer product; however, the standard can only set safety benchmarks for design and construction. Government may also introduce non-standards measures regarding the use of the product to bring about a total solution. For example a standard for bicycle helmets may be backed up with mandatory wearing requirements and public education to make parents aware of the risk of head injuries to children while cycling.

More commonly, the standard is broader than it needs to be to address the key safety problem. It may be a compete specification for the product, including performance requirements and requirements for minor safety issues, in addition to the essential safety requirements.

If one takes the example of a standard for a baby's cot, the essential safety requirements are directed towards the risk of severe injury or death. For example, the infant becoming caught between the bars of the enclosure and the risk of clothing becoming entangled with projections along the top of the side panels, either of which could lead to strangulation. Minor risks could include square edges on the legs of the cot that an older child in the same room as the infant might run into when playing. Performance requirements could include the ease of use of the drop-side mechanism by the parent and the durability of the cot.

From the public's perspective, they may anticipate that purchasing a product that complies with the national standard will deliver all of their expectations in terms of both safety and performance. However, the public may demand a more rigorous cost-benefit test when it comes to a technical regulation to ensure the government only intervenes in the market to address essential safety issues that amount to market failure. A square edge that the baby cannot reach may not, be considered a market failure, especially when square edges on other furniture around the home are not prohibited.

Simply using anecdotal evidence to define the problem may lead to the inclusion of excessive requirements aimed at preventing unusual types of accidents that are unlikely to recur. This applies to both a standard or a technical regulation. Best practice when identifying the problem during the development of a standard is to use quantitative information. Where comprehensive quantitative information is not available, qualitative information based on limited statistics is the next best option. One can then prepare a risk assessment matrix that includes data about the likelihood of a type of an accident taking place and the magnitude of the consequences associated with a hazard. If the risk is already at a tolerable level or below, there is no need to address it through the essential safety requirements in a technical regulation; however, a tolerable risk may still be managed down to a negligible level through a voluntary standard.

Fig. 5-1 ▶ Risk Assessment Matrix

	IMPROBABLE	VERY REMOTE	REMOTE	REASONABLY PROBABLE	FREQUENT
MINOR	NEGLIGIBLE	NEGLIGIBLE	NEGLIGIBLE	TOLERABLE	TOLERABLE
MAJOR	NEGLIGIBLE	NEGLIGIBLE	TOLERABLE	TOLERABLE	INTOLERABLE
HAZARDOUS	NEGLIGIBLE	TOLERABLE	INTOLERABLE	INTOLERABLE	INTOLERABLE
CATASTROPHIC	TOLERABLE	INTOLERABLE	INTOLERABLE	INTOLERABLE	INTOLERABLE

5.2.2 The baseline

In order to predict a standard's impact it is important to consider what the baseline situation would be if the standard wasn't implemented. Whether looking at an individual business or across a whole industry sector, the approach is much the same.

The simplest case is the change in costs when a standard is revised and the impacts of the old and new versions are to be compared. In this case, the baseline or business-as-usual scenario would be that the standard is not revised and continues on in its current form. This would mean that only the consequences that directly relate to revised provisions need to be considered.

Establishing a baseline is also required when considering the impact for a business or sector of implementing a standard where none was in place before. Market forces and other factors, such as the threat of litigation, may mean that some of the standard's requirements are effectively already in place across much of the sector and the purpose of the standard is simply to bring pressure to bear on a minority of businesses that are operating in a unsustainable manner. This is the most difficult type of baseline to assess and a survey of businesses and their practices is the best option to estimate the business-as-usual scenario.

5.2.3 Sustainable markets

A sustainable market is one that one that meets the community's economic, social and environmental expectations over the medium to long term. Such a market should remain relatively stable for long periods as a result of demand and supply pressures operating rationally. By contrast, instability is brought about by market players seeking to make short-term gains without due regard to the economic, social and environmental consequences, creating instances of market failure and damaging confidence.

Many economists would say that the primary role of the standards and conformance infrastructure within an economy is to build confidence in the market by preventing market failure. In a planned economy, the balance is more likely to be towards the use of technical regulations and other statutory measures, while voluntary standards and conformance measures may be more prominent in a free market economy, but both approaches serve the same goal of guarding against internal market failure.

Market failure takes many forms; however, one of the most common is the lack of certainty when buying and selling goods by volume or weight, an issue that has plagued markets since commerce began. The ancient Jewish law in the Book of Deuteronomy recognises the problem and tells merchants, 'Thou shalt not have in thy bag diverse weights, a great and a small', a reference to the practice of using one set of weights when buying goods and a lighter set of weights when selling them.

Confidence in the market also includes knowing that, at a minimum, any product will, at the time of purchase, be fit for its intended purpose, be of acceptable quality and not present unreasonable safety hazards. For example, a television set purchased new that is incompatible with the local broadcast system (VHS or PAL) is not fit for its intended purpose. If the earthing is inadequate and the casing becomes live, the set presents an unreasonable safety hazard. If a component fails within a week after purchase, then the set is not of acceptable quality.

The 2005 WTO report notes that 'safety norms allow us to consume with a confidence that would be impossible if we had to make our own judgements about safety at every turn. Rules of conduct and product standards in numerous areas of activity help us avoid inefficiency, harmful surprises, and high costs. In the case of product standards, for example, faxes can be sent around the world because fax machines obey a common protocol. Computer files can be shared because computers employ various standardized hardware and software formats.'

The WTO report further states that the 'economic cost from accidental injuries and deaths can be large. In the United States for example, there were more than 12 million accidents in 2003 from the use of consumer products that required patients to be treated in hospitals. The US Consumer Product Safety Commission estimates the economic costs of these accidental deaths and injuries at $700 billion annually'.

5.2.4 Information asymmetries

The WTO report also describes the mechanisms by which standards can act to prevent market failure, including through addressing information asymmetries.

'Information asymmetries occur when producers have information about the characteristics of goods they produce which users do not possess. Whether as end consumers or as producing firms acquiring inputs, buyers may be at a significant disadvantage compared to sellers because the latter possess information about the good or service not available to the buyer. This asymmetry can significantly hamper the efficient functioning of markets, and standards can help solve the problem and increase efficiency.'

Goods can be classified into three categories according to the information consumers can readily ascertain about them when seeking to make a purchase: search goods, experience goods and credence goods. In the case of search goods, all necessary information can be readily assessed by the consumer before purchase, for example by trying on clothing. With other goods, their quality can only be assessed through use or consumption by the consumer after purchase and then compared to the satisfaction the consumer has experienced with competitive goods in the market. These are referred to as experience goods where the use of the goods will dictate whether or not the consumer feels inclined to make a subsequent purchase. The third type of goods are those that are difficult for the consumer to assess, even with experience, either because their effect is hard to measure or the consumer has little comparative experience. These are called credence goods because the consumer must rely upon the assessments made by others whom the consumer trusts.

In the television example, a consumer cannot hope to personally assess the factors described above that would ensure the set is safe, fit for purpose and of acceptable quality. A television is an expensive and durable item. Even if one wanted to rely on personal experience, the period between subsequent purchases would be such that models and technologies will have no doubt changed.

Instead, a television is a credence good. The consumer must rely on the standards and conformance system to convert those required attributes of safety, quality and fitness for purpose into technical standards and apply conformity assessment to control the compliance of the set with the technical standard. It then becomes a matter of how the consumer can be assured of compliance, either through the effective enforcement of a technical regulation or by seeking out products bearing appropriate evidence of compliance, such as a label from a credible marking regime.

Perhaps the greatest potential information asymmetries apply to unincorporated production and processing methods (PPMs). This expression refers to aspects of the manner in which the product was produced that have no effect on the product itself and cannot be determined by examining the product. Typical examples would be the amount of carbon pollution created during the product's manufacture or the use of socially responsible labour practices. The rise of environmental and socially responsible labelling programs is a response to a consumer demand for this type of information in certain markets; and such programs form an element of the voluntary area of the standards and conformance infrastructure.

5.2.5 Diffusion of technological information

A standard can be viewed as a set rules, but equally as a repository of information, as mentioned in the earlier quote from the DIN study. The WTO report found that 'The information contained in standards can also play a role in the diffusion of technology. The information contained in non-proprietary standards is in principle accessible to everybody. In particular, standards may embody considerable technological knowledge. Firms can access and acquire this knowledge and standards can therefore serve as a vehicle for technology diffusion within or across economies. Even where knowledge is patent-protected, information registered under patents may permit useful knowledge adaptations that can be incorporated into standards'.

This value is enhanced for new market entrants unfamiliar with the levels of safety and the customer expectations of performance that have evolved in the market over time. The standard will, at the very least, set out the minimum outcomes required by the market, against which a new entrant can assess production costs and potential profit margins before committing to go ahead with a proposed new venture.

It is worth noting that a common cause of early business failure is the market entrant who seeks to launch a new product without having first researched the standards and technical regulations applicable to the product. Sometimes, that research would have shown that the perceived advantage that the innovative product delivers in one aspect of performance is only achieved by failing to address existing norms in the market for safety or for other aspects of performance. For example, a new lightweight, low cost type of motor vehicle with the potential to save on fuel usage that only achieves the weight saving by failing to include adequate arrangements to protect occupants against collisions with other, heavier vehicles.

The information transfer to industry from third-party conformity assessment and laboratory accreditation is just as beneficial. It is quite common in industry to find poorly targeted internal controls being aimed at aspects of production or testing that have little effect on final product quality, with comparatively less attention being paid to aspects that have a critical effect on the quality of the output. For example, in chemical manufacturing, variability in quality is often greatest during the first hour of production each day when the processing equipment is still coming up to maximum temperature. If a sample for testing is taken off the production line once an hour throughout the day, starting when the first hour's production has been completed, off-specification product may not be detected.

The feedback from third-party systems audits helps educate industry, especially new market entrants, seeking to optimally control sources of variability in production and testing.

5.3 Benefits of standards

5.3.1 Beneficiaries of standards

Any given standard is aimed at addressing the identified problem in the market by delivering one or more of the following objectives—

a) Meeting community expectations of safety.
b) Permitting interconnectivity.
c) Meeting community expectations of performance, possibly including environmental performance.
d) Improving efficiency by the use of common practices.
e) Facilitating meaningful comparisons.
f) Providing a common basis for trade.

The beneficiaries may be industry or the broader community. As a general rule, those measures in the standards and conformance infrastructure that are mandated in law are more likely to be those where, left to itself, the market would fail to deliver an acceptable outcome for the community. Thus, government intervention in the market is justified. The intervention is often related to safety; but also includes more fundamental aspects of the market like legal metrology and performance standards for credence goods.

Measures for voluntary application are more likely to benefit business. In that case the benefit to business outweighs the costs of implementation and the market will adjust itself, once an agreed benchmark is established through the standard.

The benefits of implementing a standard for a business may include:

a) Enhanced market share due to market demand for standards compliance.

b) Preferential treatment by government.

c) Simplifying business to business trade.

d) Improved production efficiency.

e) Reduced hence inventory costs as a result of the need to hold fewer varieties.

The widespread adoption of ISO 9001 is an example where government policies, rather than regulation, had a significant impact on voluntary use of a standard. In the early 1990's it became common for governments to include demonstrating compliance with the ISO 9000 series of quality management standards as a condition for businesses becoming a preferred tenderer. Those businesses, in turn, required their suppliers to do the same; and so the use of these standards spread across the economy as part of the way a business would prepare itself for market entry, rather than in response to a requirement in a specific contract. By 2007, over 950,000 businesses in 175 economies were third-party certified against ISO 9001, not including businesses that self-declared compliance with the standard.

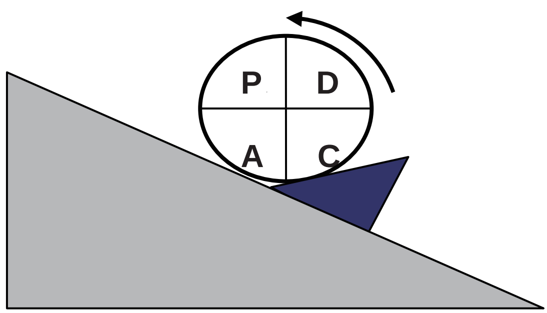
A different example of preferential treatment by government is within co-regulation. For example, in environmental regulation, certification to ISO 14001 is often one of the indicators that environmental regulators use to rate businesses according to their risk of non-compliance with environmental regulations. The benefits of a low risk rating may include reduced government fees and fewer inspections.

5.3.2 Standard or no standard

If a standard is developed as the solution to a problem, how do we know whether the problem still exists?

Typically, the market becomes habituated to the longstanding presence of a standard and if the standard was to be withdrawn, this may not lead to immediate consequences of market failure. This is best demonstrated by considering the diagram frequently used in quality management to demonstrate the role of standards in that field (see Figure 5.2). If you think of a company moving up the slope of improved quality, using a *plan, do, check, act* (PDCA) cycle to drive improvement forward, as shown in the figure, the role of the quality management standards is represented by the blue wedge. It stops the hard-won gains in quality being lost by ensuring that the fundamentals of quality assurance continue to be observed.

Standards in many fields act in a similar way for a business that has gone beyond minimum compliance. The standards exist in the background, once the business's own internal specifications have been established.



◄Fig. 5-2
The role of standards in quality management

Removing the blue wedge may not have any immediate consequences, until such time as forces like pressure for cost-cutting to match competitors come into play, at which time the circle starts to roll backward down the ramp in the direction of market failure. For example, safety becoming compromised during periods of difficult commercial circumstances and pressure to cut costs.

The test of withdrawing the standard is not just a means of validating its continued existence. It is also a means to determine that a standard has outlived its usefulness; in which case withdrawing it will reduce costs without compromising benefits to the community.

There are cases where market failure was caused by a failure of stakeholders to communicate with each other. The process of finding consensus in the development of the standard may have opened up lines of communication, allowing the market to correct itself.

As an example, there was an Australian Standard glossary of terms developed in the 1980's for use in the book trade. The market failure to be addressed was that book wholesalers used the term 'out of stock' to also cover 'out of print'. This frustrated book retailers who didn't know whether, if they placed an order, they could expect to receive copies of a book once stocks were replenished, or whether the book was simply no longer available. The book wholesalers had the relevant information, but didn't see it as particularly important, at least not from their own, inward looking, perspective.

Once the standard was published with 'out of stock' defined as 'temporarily unable to supply' and 'out of print' added to the vocabulary, this terminology quickly became the norm in the industry. By 1990, the market failure had been eliminated and maintaining the standard was no longer necessary.

A more insidious case is the prospectively-oriented standard developed to support a technological innovation that was predicted to become widespread; but failed to do so. The standard may then become a 'sleeper' that is not actually being used to resolve a current problem, but nonetheless continues to influence the functioning of the market.

This is a particular risk where 'commissioned' standards are developed by national standards bodies, i.e. the standards body accepts an up-front fee from an interested party to develop a standard. Often, it is the proponent of a new invention that is prepared to invest money this way with a view to having a bespoke national standard written around the particular product. When that invention fails to be accepted by the market and disappears, the only role that the national standard is playing is providing potential new entrants with misleading information about benchmarks in the market.

5.3.3 The financial benefit provided by specific standards

Some standards can play a part in a very substantial financial benefit; although, it is not always easy to measure the contribution to that larger benefit made by the standard. For example the world trade in coal is based on the grade of coal, established in accordance with ISO standards, such as ISO 11760 *Classification of coals*. The total world trade in coal in 2003 was 719 million tonnes, comprising 520 million tonnes of steaming coal (72%) and 199 million tonnes of metallurgical or coking coal (28%). The price of steaming coal in late 2009 was around $US 75/tonne with coking coal approximately double that price.

To say that no trade in coal could happen without the standards would be overstating the standards' contribution because coal was traded long before those standards existed. The standards do, however, bring order to the inspection of consignments of coal and to price setting based on grade.

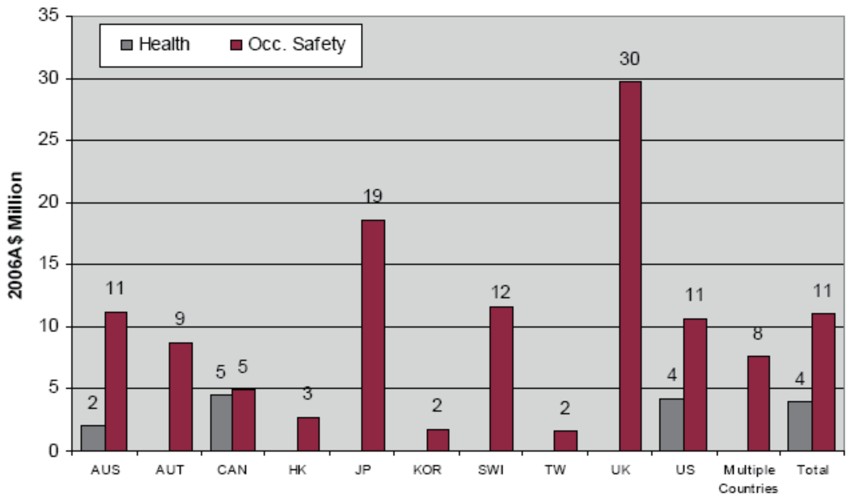
There are other examples where we can be more confident in saying that the trade did not exist prior to the development of the relevant standards. A good example is trade in carbon credits from afforestation under the Kyoto Protocol. Until there were standardised methods for estimating the mass of carbon sequestered by a given forest in a year, there was no way of putting a precise value on the contribution of particular forestry activities to removing carbon dioxide from the atmosphere.

More difficult to assess is the benefit of a prospective standard aimed at meeting a potential future need or supporting an emerging technology. For example, the development of standards supporting an IT protocol. As Swann observed 'there is general agreement that the publication of a standard is not enough for it to create economic benefits. The value to business, and indeed the economy at large, comes when the standard is used.'

5.3.4 Value of a statistical human life

Where a safety benefit flows from a standard, the actuarial value of a statistical human life (VSL), is one measure of benefits that can be set against the costs resulting from the standard's implementation. That value is often assessed based on court judgements in compensation cases and may be assessed differently according to the sector where the life was lost. Figure 5.3 provides some selected estimates of VSL from studies undertaken in various economies, calculated in Australian dollars (AUD). A nil value in the figure indicates that no data could be found.

Utilising the VSL type of approach provides rationality to the econometric assessment of benefits in what may be an emotionally sensitive discussion. Thus,



◀Fig. 5-3
Value of a statistical life in healthcare and occupational safety (AUD)

if a new occupational safety standard in Australia will cost $20 million annually to implement and is predicted to save two lives each year, it would be justified according to the values in Figure 5.3.

The spread of values used in different sectors of the same economy can be cause to question how rational the means of calculating the value of a statistical life might really be. For example, if the same implementation costs were associated with a new standard in healthcare in Australia, say one for sterilisation methods in a hospital, it would need to save five lives per year in order to be justified. This reflects the fact that industrial accidents typically involve a relatively young, healthy worker with dependents; whereas, the typical patient in hospital is older, less likely to still have dependents and will have a pre-existing medical condition. In calculating compensation for an accidental death, a court will view the young healthy worker's life as being more valuable, in purely financial terms, than the life of an elderly person who was no longer bringing in an income and who had a shorter life expectancy regardless of the accident.

The other issue for consideration is the fact that predicting the number of lives that will be saved by introducing the standard compared to the baseline situation is notoriously speculative. The causes of fatal accidents can be analysed using a fault tree analysis and the standard may block one pathway. However, the result may be that a different branch of the fault tree simply becomes more prominent.

For example, the introduction of higher energy absorption requirements into car crash testing standards has not reduced the numbers of fatalities in motor vehicle accidents in Australia as had been predicted when the new requirements were first introduced. One reason is that the speeds involved in fatal accidents have continued to increase and now typically involve levels of energy much greater than those envisaged in the standard and beyond the technological capacity of any motor vehicle to absorb. The projections used to justify the costs associated with the new requirements failed to predict this increase in the level of risk taking by certain sectors of the community and the trend towards driving at well in excess of the speed limit.

While the standards probably achieved their goal in terms of preventing fatalities associated with crashes up to the speed limit, it is impossible to point to any statistics that justify the added financial costs of the standards' implementation. All one can say for sure is that the road toll has not come down as anticipated. In other words, the measure for validating the success of the standard (decreasing deaths) has proved to be ineffective, possibly because so many factors affect fatalities, not just vehicle construction standards.

5.3.5 Quantified risk assessment

Another approach to apply quantified risk assessment methodologies to determine the benefits that will flow from a standard.

Quantified risk assessment is most useful when considering involuntary risk, where a person is going about their daily life, without having any control over a risk that is being externally imposed upon him or her. For example, the risk to passengers associated with a new high-speed train. In such circumstances, the numerical level of risk can be compared to common risks that exist in the community today and are considered to be acceptable.

Taking Australia as an example, the loss of life due to motor vehicle accidents is considered to be at an unacceptable level (over 1600 per year or 8 x 10-5) and the actions of government to deal with the problem are constantly being elevated. On the other hand, the rate of death due to snake bite of 3.2 deaths per year, is considered acceptable. Such a death is considered bad luck and there is no suggestion of government introducing new measures, such as culling the snake population, to reduce the risk to the roughly 4 million Australians living in regional areas where snakes are prevalent.

Based on this type of consideration, a typical annualised acceptable level of risk in Australia is 1 x 10-6. In other words, if a person was to be constantly exposed to the risk for one year, the chances of the person being killed during that year is less than 1 in 1,000,000.

A practical application of this technique was used in the development of the Australian Standard for LPG filling stations for cars. There are a number of mechanical safety measures required by the standard and the rate at which each has historically been known to fail was available. Only if all the safeguards failed would there be a risk of an explosion. The size of the explosion involved in different historical accidents was also known, including how far a person would need to be from the LPG dispenser at the time of the explosion in order to survive it. This information was then fed into a calculation to determine exposure to risk.

The result was that, at a distance of just under 30m from the dispenser, the annualised level of risk of death due to an LPG explosion was 10-6 which is no more than typical background risk. Thus, provided that dispensing systems were compliant with the Australian Standard and were able to be located at least 30m from the nearest property boundary, the fact that cars were being filled with LPG presented no substantial additional risk to people living in the surrounding properties. The standard, having resolved the safety question about filing stations, provided the basis for the use of LPG as a fuel for cars operating in suburban areas in Australia.

Quantified risk assessment methodologies provide a very accurate prediction of the benefits of a proposed safety standard, using existing community norms as a baseline. The limitation to the application of quantified risk assessment is that it requires a significant quantity of data regarding the likelihood and consequences of systems failure, which may not always be available.

5.4 Cost impacts of standards

5.4.1 Business cost impacts

The cost impacts of implementing a standard on a business include:

a) The increased direct labour and materials costs compared to the business-as-usual baseline.
b) Additional overhead costs, including record keeping, etc.
c) Additional costs associated with demonstrating compliance, such as testing and certification expenses.
d) The costs need to be assessed on a per unit basis, then expanded to an annual basis for a business or an industry sector.

These costs will, of course, be passed onto the customers of the business, so in a sense they are also costs imposed on the community.

Standards, in general, are not intended to be applied retrospectively to actions that have taken place in the past. Thus, if the standard specifies requirements to be observed during the design and construction of a building, the building will not be expected to be rebuilt each time the standard is updated. This is referred to as ‘grandfathering’, which means that the standard in place at the time of construction is valid for the life of the building. However, an operational standard, for example covering safe practices when cleaning the building’s exterior windows, would not be grandfathered; because the action takes place in the present, every time the windows are cleaned. Therefore, the impacts of the standard and the associated costs must be estimated prospectively as they apply to new actions.

5.4.2 Prescriptive and performance-based standards

There are differential cost impacts according to whether standards are prescriptive or performance-based. A performance-based standard is one that relies on methods of assessment that directly address the hazard or mode of failure and are independent of design solution. For example, ISO 8124-1, the international standard on general aspects of the safety of children’s toys, is performance-based. For instance, it employs a test cylinder with dimensions based on the size and shape of a child’s throat. A toy, or part of a toy, that can pass through the cylinder is deemed to be a choking hazard and will not be permitted in toys designed for children less than 3 years of age.

Design standards for the construction of buildings are often performance-based, being directly derived from the physical properties of construction materials.

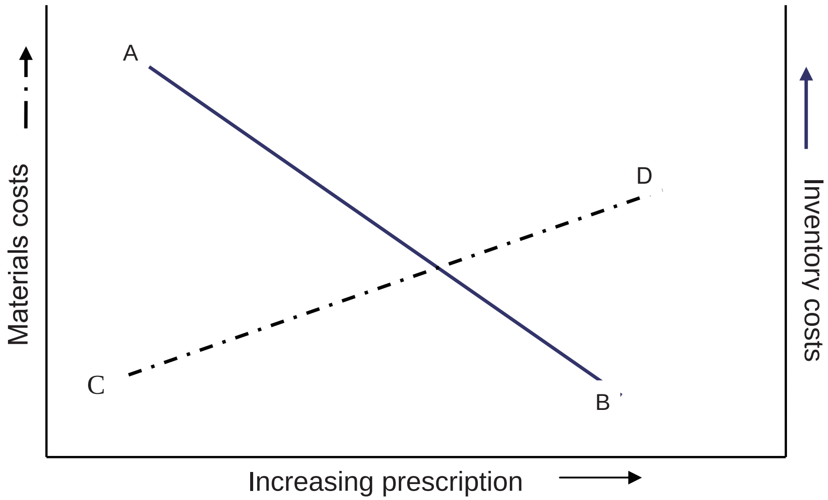
However, they may also contain a 'deemed-to-satisfy' solution based on the use of traditional construction methods. This provides scope for innovation and cost saving through the performance-based approach; but it also provides a simple prescriptive solution suitable for small jobs and where the cost of optimising the design would outweigh any benefits in materials savings.

At the opposite end of the prescription continuum, standards for interconnectivity provide their benefit through a rationalisation of options and must be highly prescriptive in order to achieve that goal. For example, there are numerous designs of electrical plugs and sockets in use around the world, each of which achieves its purpose with a similar level of efficiency. However, most governments have sought to mandate a single design for plugs and sockets to make life simpler for citizens and improve economic efficiency. This is illustrated in Figure 5.4, below.

The line A-B represents the range of inventory costs depending on whether a wide variety of options are allowed; or alternatively, relatively few designs are permitted under prescriptive requirements. This can be seen by visiting a hardware shop where there will be many different designs of taps (faucets) that perform the same function, compared to a smaller number of designs of electrical wall sockets.

The line C-D represents the opportunity to save on materials costs if there are fewer restrictions on aspects such as choice of materials or dimensions. For example, again in the hardware shop, many items of plumbing that were traditionally made of metal or ceramics are now made more cheaply from plastics because the relevant standards for plumbing products tend to be expressed in terms of performance outcomes only. Thus, the impacts flowing from the opportunity to reduce materials costs through innovative design must be balanced against the increased inventory costs associated with carrying multiple types of components that serve the same purpose.

Fig. 5-4 ▶ Optimal level of prescription in standards based on costs



The benefits of rationalising options through prescription doesn't just apply to documentary standards, it also applies in other elements of the standards and conformance infrastructure, such as metrology. The use of imperial and metric measures within the same economy can lead to inefficiencies, such as the need to hold multiple stocks of hardware, or more serious impacts such as confusion about speed limits. An extreme example was the loss of the Mars Climate Orbiter mission in 1999 due to confusion over whether the distance to the surface of the planet was being measured in metric or imperial units.

5.4.3 Outcomes-based technical regulations

Like with standards, technical regulation have different impacts according to the level of prescription. Outcomes-based technical regulations are underpinned by some of the same goals as performance-based standards; but there are important differences in both their design and the effect they have on the market.

The *APEC Information Notes on Good Practice for Technical Regulation* propose that technical regulations should be outcomes-based to minimise the costs on business and promote innovation. This implies that it should only be a breach of the law if one fails to achieve the community's expectations of safety or other similar outcomes, with industry being provided with maximum flexibility in how to discharge that obligation. The logic behind this is that industry will be able to find the most cost effective solutions to meet market demands if it is free to apply its own ingenuity with minimal government intervention.

The antithesis of outcomes-based regulation is prescriptive regulation where the technical regulations closely constrains permissible solutions. Prescriptive regulations are often used where there are high levels of public risk, for example in the handling of dangerous goods, where the opportunity for cost savings takes a back seat to public safety. However, prescriptive and outcomes-based regulation are not absolute concepts and there is a continuum of increasing levels of prescription in technical regulation. The important point to note is that the most efficient technical regulations are based on the correct level of prescription that will deliver the required effect on behaviour without unduly constraining innovation.

At the extreme end of the continuum, an outcomes-based regulation may simply be an obligation to maintain a safe and healthy workplace. Such a regulation would mean that if a worker is injured or suffers an occupational disease, there is prima facie a breach of the law; and the only remaining question would be the level of the penalty to be imposed, based on the extent to which the employer took preventative action to mitigate the risk. That mitigation may include actions such as complying with voluntary standards for machinery guarding and codes of practice for minimising workers' exposure to occupational noise. However, the employer may also devise novel solutions to mitigate risk, so long as they have been designed with due care.

However, going to the extremes of outcomes-based regulation isn't always the perfect solution. In such a regulatory environment, an employer, especially in a small business, may decide that their legal obligations are so broad-ranging and uncertain that it is more cost effective not to take any steps to mitigate risk and just hope that a (statistically rare) accident doesn't occur.

A slightly more prescriptive type of system is to establish multiple required outcomes within the technical regulation and couple this with prescriptive deemed-to-satisfy solutions that provide the benchmark for the extent to which industry must address the required outcomes in order to fully discharge its legal obligations. This is essentially how the European regulatory system operates with the Directives setting out the required outcomes and the harmonised standards acting as deemed-to-satisfy solutions. In the previous workplace example, the multiple required outcomes may include a limit on the noise exposure of a worker averaged over 8 hours and requiring pinch-points on rotating machinery to be guarded.

In theory, a business is free to employ a novel solution, either by using an alternative technical standard or taking a first principles approach, so long as it meets the required outcomes and delivers an outcome at least equivalent to that delivered by using the deemed-to-satisfy solution. In practice, demonstrating equivalence from first principles can be expensive and highly innovative solutions are generally only feasible where a significant cost saving will result. If the goal is to promote maximum flexibility of design solutions, this is more cost-effectively achieved through having performance-based standards, rather than outcomes-based technical regulation.

This system has the benefits of providing industry, and small business in particular, with the certainty of prescriptive requirements that will fully discharge its legal obligations; while at the same time, still ensuring that innovation is not prevented, because an equivalent solution can always be proposed, albeit at a cost.

Table 5.1 shows the results of a 2009 APEC survey regarding regulation of the safety of toys. The economies in Column A have adopted a prescriptive regulatory approach, those in Column C have adopted an outcomes-based approach and those in Column C have adopted a middle course.

Table 5-1 ▶ Regulation of safety of toys in APEC Economies

A	B	C
Safety requirements are specified in mandatory safety standards and/or regulation	**A mix of the two; some mandatory standards and a general requirement for toys to be safe**	**A general product safety regime where all goods placed on the market are required to be safe**
Australia	China	Papua New Guinea
Canada	Hong Kong	Singapore
Chile	Japan	Brunei Darussalam
Indonesia	Malaysia	
Korea	New Zealand	
Mexico	Peru	
Chinese Taipei	The Philippines	
Russia	Viet Nam	
Thailand		
United States		

A system with prescriptive technical regulation for toy safety that references a performance-based standard, like ISO 8124, will deliver minimal restriction on innovative toy design; however, there will be significant cost impacts in terms of re-testing a toy that, say, has been designed to comply with the European standard, EN 71. In an outcomes-based regulatory system, evidence of compliance with a different standard, like EN 71, would generally be acceptable without re-testing, facilitating imports.

5.4.4 Cost impacts on the community

There is a cost to the community associated with any standard, over and above the passing on of costs incurred by business. The implementation of a standard across a market reduces choice by eliminating the option to purchase cheaper products that do not meet the standard. Given that industry often has a prominent role in establishing the requirements in standards, there is the potential to raise the requirements above that which is strictly necessary to resolve the *problem*, simply because industry is well-positioned to deliver enhanced performance or safety, albeit at a higher retail price. Apart from maximising profit per unit sold, enshrining this elevation of base levels in the standard would protect existing players against a new competitor coming into the market with a less expensive, more basic model.

This phenomenon isn't always easy to demonstrate; however, a simple example is the cost of running a consumer durable product that uses energy, such as an automobile or an electrical appliance, like a refrigerator or an air conditioner. For the purpose of this exercise we should assume that the purchaser is only concerned with costs, not any other consideration like a commitment to reducing the environmental impacts.

The total cost to a consumer an energy-using product is defined by the following equation:

Where:

$$LCC = IC + \sum \frac{OC_t}{(1+r)^t}$$

LCC = life cycle cost
IC = initial or purchase cost
OCt = operating cost in year t
r = discount rate
t = years since purchase

This cost includes the purchase cost plus the cost of energy the product will use each year from when it is purchased up to year t.

Energy labelling is often used with this type of product, whereby a label is attached to the product in the showroom that sets out how much energy the product will use per year based on average usage patterns. Like other forms of consumer information standards, energy labelling is intended to allow consumers of electrical appliances to make informed choices using a common, easily understandable presentation of anticipated energy consumption.

A more traditional type of standard for an energy using product is one that sets the minimum energy performance (MEPS) an appliance must meet. Such a standard is often introduced with the force of a technical regulation to protect the less discerning consumer, who fails to grasp the implications of energy labels, from products that are unreasonably energy hungry. However, if the level of minimum energy performance is set too high, the initial cost, IC, will dominate the equation and may not be offset by the savings on energy consumption over the product's life. The consumer would thus be denied the option to choose the most cost effective product. For example, if the consumer is only planning to use the appliance lightly, such as an air conditioner in a guest bedroom, a less efficient product may be the cheapest option. On the other hand, consumers need to be protected against purchasing a product that is so inefficient as to make running the appliance, even for a short time, unreasonably expensive.

To achieve maximum economic efficiency, the level of the requirements in the standard should be set at the minimum necessary to prevent market failure, but no higher, thereby avoiding unjustified costs for customers. This is not always an easy proposition to quantify, but if the *problem* is clearly defined, it is easier to measure it against the solution in the standard. This is why with, regulatory impact assessments, there is an emphasis on finding the most cost-effective solution to the problem.

Reference

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- Based on ISO 9004
- Speech to the parliament of New South Wales by Lee Rhiannon MLC, 1 July 2006, Hansard.
- For example AS 4978.1 Quantification, monitoring and reporting of greenhouse gases in forest projects - Afforestation and reforestation
- Swann, P. G. M (2000) "The economics of standardization, Final report for Standards and Technical Regulations Directorate", Department of Trade and Industry. London
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Chapter 06

Legal Impacts

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Australia

Learning Objectives

After completing this chapter, you should be able to:

a) Identify each of the principal ways that standards and conformance measures interface with the law
b) Explain the process of regulatory impact assessment
c) Identify the different conformance measures that might be used in the design of a particular regulatory strategy

Overview

This Chapter considers the legal impacts of standards and conformance. There are many different ways that standards are used in the law, but the most significant are—

a) Statute law
b) Contract law
c) Common law
d) Competition law

When one talks of 'mandatory' or 'regulatory' standards, this generally is taken to mean those referenced in statute law. However, if two parties agree to rely upon a 'voluntary' standard in a contract, then it is still legally enforceable. The difference is that a party to the contract, rather than a regulatory agency, will be responsible for enforcement.

There is also what some call 'grey letter' law. In other words, compliance with a standard is not mandated in statute law, but an enterprise will find great difficulty in doing business if it doesn't comply. That sort of market driven compliance is generally beyond the scope of this Chapter.

It is important to remember that the law deals with the actions of persons, not with inanimate objects. While in common parlance one might say that a certain product is regulated, it is not the product itself that's being regulated. It may be the supply of the product, or its manufacture, its maintenance or even its disposal, all of which are actions undertaken by persons.

In the legal context, where we talk of persons, this includes corporate bodies, such as companies, partnerships, registered charities, etc.

6.1 Statute law

Statute law refers to legal requirements enacted in legislation by government. In relation to standards and conformance, statutory legal requirements include technical regulations and legal metrology. There may also be laws governing the establishment of elements of the national standards and conformance infrastructure, such as the national standards body or the national accreditation agency, defining the roles, responsibilities and powers of those bodies.

6.1.1 Mode of reference

It is common for standards developed by a standards development body (either government or private) to later be referenced in law. There are a number of ways this can happen—

a) **Dated adoption**. Compliance with a specific version of the standard can be made a condition for undertaking a certain action. For example, a product may not be supplied to the public unless it complies with JIS XXXX-2009.
b) **Undated adoption**. Compliance with the standard, including subsequent versions, can be made a condition for undertaking a certain action. For

example, a product may not be supplied to the public unless it complies with JIS XXXX-2009, as amended from time to time.

c) **Deemed to satisfy**. Compliance with the standard, normally as amended from time to time, is acceptable as one way of meeting the legal requirements, but there may be other ways. This is typical of the required outcomes/deemed-to-satisfy solution approach.

In the above option a) the regulatory agency is taking full responsibility for assessing the suitability of the content of the standard. In options b) and c) the regulatory agency is, at least in part, devolving some responsibility to the standards development body by recognising the standard as a suitable benchmark, even if it changes. This is a recognition of the process through which the standard is developed, as much as a recognition of the content of the standard itself.

6.1.2 Version control and transition

Where a standard is referenced ‘as amended, from time to time’, the legal requirements applying at any specific point in time must be somehow fixed in order to give certainty to industry and to enable the prosecution of breaches. For example, that point in time may be the day that a particular product was supplied to a consumer, or the day that approval was given to commence construction of a house.

Often a period of transition is allowed during which either the requirements of the old or the new edition are acceptable as discharging the legal requirements. This, however, does not imply version shopping, i.e. the process of picking out some requirements from the old edition and some from the new edition. During the transition period, the options are to comply with either all of the old edition or all of the new edition.

6.1.3 Referenced standards

It is common for technical standards to make reference to other standards in such a way that compliance with the referenced standard becomes part of the requirements of the first standard. These are called normative references. An example may be a standard for timber framing in a building making a normative reference to a standard for nails. The standard for nails, in turn, may contain a normative reference to a standard for zinc coating of metal products and that standard could contain a normative reference to a standard method for testing the resistance of metal products to corrosion.

When a technical standard is adopted into a technical regulation, the normative references also assume an enhanced legal status. Even if building regulations mandate the use of a specific edition of the timber framing standard, the regulations are also indirectly mandating the whole chain of referenced standards, where the edition to be used is less clear.

If, for example, a new edition of the standard for the testing of the resistance of metal products to corrosion is issued in which the old outdoor exposure to the elements test is replaced by a new accelerated laboratory method, which of these editions is required to be used under the law?

The technical standard may use a mix of dated and undated normative references to indicate whether or not the updated edition should be used; however, an undated reference may go against legal drafting policy that requires dated adoptions only in technical regulations.

One approach is to say that the version of each referenced standard in place on the day that the standard became effective in law is the one to be used as the reference standard for legal purposes. However, in the timber framing example, the nail manufacturers and the testing bodies will most likely have moved on to use the latest standards, especially if the new laboratory test is quicker and cheaper than the old outdoor exposure method. Unfortunately, this would mean that builders would be unable to purchase nails that meet the letter of the law. This is a fictitious example, but it demonstrates a common problem.

An alternative approach is to leave it to the courts to decide each instance of a normative reference, based on which version a reasonable person might use. This allows for the fact that a revision of a referenced standard may, on the one hand, simply be an update to clarify a few matters; or on the other hand, the new edition may represent a major change of direction such that the standard no longer serves the same intent.

Thus, a technical regulation based on a voluntary technical standard and its subsidiary referenced standards can have more far-reaching impacts than was initially anticipated.

6.1.4 Regulatory Impact Assessments

Undertaking a Regulatory Impact Assessment is a means of reviewing the expected financial consequences of proposed technical regulations, before they are enacted, including assisting in identifying the most cost effective regulatory option.

In 1980, the Regulatory Flexibility Act was passed in the United States and became the first example of mandatory Regulatory Impact Assessment of new legislation. This Act requires regulators to explicitly evaluate the effect of regulation on small businesses. Regulatory Impact Assessments, as a tool for reviewing the financial impact of regulation, including technical regulations, on business and the community as a whole became widespread during the 1990's in other developed economies. The OECD has recommended the use of Regulatory Impact Assessments, especially in developing economies to ensure that legislated measures are well targeted.

Typically, a preliminary Regulatory Impact Assessment is released for public consultation at the same time as the draft regulation. It should examine the fiscal implications of each new requirement and permit businesses and the wider community to judge how they will be impacted by it. Some of the issues to be considered are—

a) Labour: Will businesses incur additional labour costs? For example, more time may need to be spent on reviewing designs or checking quality.

b) Notification: Will businesses incur costs when they are required to report certain events? For example, businesses may be required to notify a public authority before placing a new product on the market.

c) Education: Will costs be incurred by business in upgrading the training of staff? For example, staff may need a formal qualification if a trade, such as welding, is to become a licensed occupation.
d) Permission: Are costs incurred in seeking permission to conduct an activity? For example, businesses may be required to apply for a licence before being permitted to manufacture food.
e) Purchase cost: Are businesses required to purchase more expensive raw materials or new equipment? For example, businesses may be required to replace machinery in order to meet a new standard.
f) Record keeping: Are businesses required to keep records up to date? For example, businesses may be required to keep records of accidents that occur at the workplace.
g) Enforcement: Will businesses incur costs when cooperating with audits or inspections? For example, businesses may have to bear the costs of supervising government inspectors on-site during checks of compliance while manufacturing pressure vessels.
h) Signage and documentation: Will businesses incur costs associated with notifying third parties? For example, businesses may be required to display warning signs around dangerous equipment, or to display a sign at the entrance to home-based business premises.
i) Procedural: Will businesses incur non-administrative costs? For example, businesses may be required to conduct a fire safety drill several times a year.
j) Indirect effects: Are there any other business compliance costs (including indirect costs such as certification body fees, consultants or lawyers) associated with the regulatory proposal? For example, a move to a more outcomes focussed regulation may mean a small business needs to employ a consultant to advise on the practical steps it needs to undertake to meet legal obligations.

As well, the cost impacts on government and the wider community need to be taken into consideration. The costs of administration and enforcement, such as additional inspection staff and staff to process applications must be included.

The benefits also need to be calculated and may include any relaxations in requirements for business, along with benefits from enhanced efficiency.

Ideally more than one option should be included in the proposal, so that a range of approaches may be considered. The benefits do not need to outweigh the costs in financial terms, because some of the benefits will be intangible, such as improved confidence in the market or enhanced safety. However, when weighing up the options, the most cost efficient option to achieve the desired policy outcome should be identified.

The outcomes from the public exposure of the draft Regulatory Impact Assessment should be taken into account in shaping the final standard. How the issues raised in the comments should be set out in the final Regulatory Impact Assessment which is presented to the decision makers in government who will determine whether or not the regulation should go ahead. The final Regulatory Impact Assessment should also be made public to provide transparency.

6.1.5 Legal metrology

The International Vocabulary of terms in Legal Metrology (VIML) defines legal metrology as:

> *" Part of metrology relating to activities which result from statutory requirements and concern measurement, units of measurement, measuring instruments and methods of measurement and which are performed by competent bodies*
>
> *NOTES*
> *1. The scope of legal metrology may be different from economy to economy.*
> *2. The competent bodies responsible for legal metrology activities or part of these activities are usually called legal metrology services."*

In most economies this would mean that legal metrology embraces measurements and measuring instruments that are:

- used and in use for trade;
- used for regulatory purposes; and
- used for contractual purposes where a legal dispute is based on measurement.

In many economies, measurements for trade are defined to comprise measurements that determine the consideration of a transaction or a tax. Such measurements include measurements of the amount of product in a transaction as well as measurements of quality parameters of a product (such as grain protein and moisture measurements) that determine the consideration of the transaction. An example of a measurement in use to levy a tax is a measurement for the purpose of fuel excise payment.

Examples of regulatory measurements include traffic measurements of speed and breath alcohol content, measurements used to monitor the environment, and occupational health and safety measurements.

In many economies the requirements for traceability to primary standards of measurement (and thereby the SI system of units of measurement) is prescribed in legislation. Accordingly, where a dispute arises between two parties to a contract based on measurement and the dispute is dealt with by a court, the matter becomes legal metrology.

In summary, legal metrology concerns practical measurements made and used on a daily basis in the community. These measurements rely on the legal metrology infrastructure (metrological control systems and the legal traceability systems) embodied in the legislation of the economy.

6.2 Conformity assessment and inspection

Within statute law, the fact that a technical regulation exists is only one element governing its impact; the manner in which the technical regulation is enforced is equally important to providing an effective and credible regulatory regime.

The level of rigour in the regulatory inspection system will, in general, be matched to the likelihood of non-compliance and the consequences of a non-compliance. In other words, it should be a risk-based system.

There are a number of options for inspecting compliance depending on the nature of the activity being regulated, although they all have some common themes.

6.2.1 Inspection during construction

Inspection during construction is often used in the regulation of activities where the consequences of non-compliance are high, such as buildings, pressure vessels and ships. These are characterised by not being mass produced and any faults not being easily detected by inspection of the final item. Corrective action may also be very difficult after construction.

Inspection during construction would typically involve:

a) Submission of the plans for approval by the regulatory authority prior to construction commencing.
b) A number of inspection visits by the regulatory authority or an approved agent during construction to ensure that construction was proceeding in accordance with the approved plans.
c) A final commissioning inspection by the regulatory authority or approved agent prior to the item being given permission to go into service.

The costs involved with inspecting each individual construction, be it a ship, pressure vessel or building, are necessarily high; and inspection may be done on a cost-recovery basis so that the inspection costs are passed onto the business in the form of approval fees which the business will seek to recover from the customer.

6.2.2 Mass-produced products

For mass-produced products, there are two main options to assess legal compliance, although they may be used in combination: pre-market assessment; and inspection in the marketplace.

Pre-market assessment refers to a mandatory requirement that compliance be assessed by a recognised body prior to a product being supplied to the public. It takes one of the following forms—

a) **SDoC** A supplier's declaration of conformity (SDoC) is the most basic level of mandatory conformity assessment. The declaration may need to be lodged with the regulatory authority or it may be a statement on the product or its packaging, like applying the CE mark. In either case, the supplier would be expected to hold internal records that compliance had actually been assessed.
b) **Type testing** The regulatory authority requires the business to submit a certificate from an approved testing body stating that a sample product had

been tested and found to comply with the relevant technical regulation. If found satisfactory, the regulatory authority would then register the product, approving it's supply. The registration number and/or symbol may be applied to each product before it is supplied. This approach is commonly used with electrical appliances.

c) **Product Certification** The product is required to be subjected to third-party conformity assessment by an approved certification body. For example, ISO Type V certification includes type testing, assessment of conformity assessment processes, periodic inspection of manufacturing and testing of samples taken from the production line. This approach is commonly used with high-consequence products like fire extinguishers and motor cycle helmets where failure of an individual product to function correctly in an emergency could lead to injury or loss of life.

Table 6-1 ▶ Mandatory pre-market requirements for toys in APEC economies

	Licensing of business involved in toy manufacturing	Licensing of distributors or retailers	Required use of a safety mark, seal, or other statement that is a claim of conformity or safety	Required use of third-party certification mark (the certifying third party is appointed by the government)
Canada				X (only for electric toys) (No)
Chile			X	
China	X		X	
Indonesia				X (Yes)
Japan			X	
Korea			X	
Mexico				X (Yes)
Malaysia			X	
Papua New Guinea		X		
Peru	X	X	X	
The Philippines	X	X	X	
Russia	X	X	X	
Chinese Taipei			X	
Thailand	X	X	X	
Viet Nam			X	X (Yes)

Table 6.1 relates to the 2009 APEC survey on the regulation of toys, showing those economies that require mandatory pre-market assessment. The table also includes the licensing of manufacturers and others in the supply chain which is another tool used by government in product safety regulation, normally in conjunction with SDoC. Although strictly speaking, this type of licensing isn't considered to be part of product conformity assessment, it provides a mechanism to directly oversee those supplying product, making licensing a useful tool for enforcement purposes.

A different approach to conformity assessment is inspection in the marketplace. As the name suggests, this involves the regulatory agency taking samples from products being offered for sale and checking them for compliance. If this approach is used alone, without any pre-market inspection, it implies a high level of confidence that the likelihood of non-compliance is low. This can operate reasonably well if the main avenue for wholesale and retail supply is through large, well-established businesses that are motivated to protect their reputation.

Inspection in the marketplace is also a useful tool where the technical regulations are so broadly cast as to include the supply of second-hand goods. For example, the risk to the safety of children posed by second-hand child restraints (for use in motor vehicles) depends on the history of the product, which may have already been stressed to its limits in a previous accident. Because these mass-produced goods will each have a unique history when supplied second hand, inspection in the marketplace is the most effective option.

The widespread use of the internet for retail sales has impacted significantly on the effectiveness of existing enforcement regimes for technical regulations covering consumer products. Inspection in the marketplace is particularly difficult when that marketplace is in cyberspace and suppliers can easily change identities. Mechanisms to inspect imported products at the border for evidence of pre-market assessment are more difficult with internet sales because the products come in one by one addressed to the final customer, rather than in commercial quantities addressed to importing companies.

Of course, government is struggling to come to terms with the many different ways that the internet can be used to circumvent regulation, so technical regulation is hardly alone. The most effective tool that government can use to prevent internet market failure is education about the need for conformance with technical regulations and the potential consequences of using non-compliant products.

6.2.3 Inspection of operations

Some technical regulations deal with on-going operations, such as the hygiene conditions in a plant preparing food, guarding of machinery in a workplace or maintaining a motor vehicle in a roadworthy condition. Here, there are two options—

a) Regular schedule of inspections (perhaps annually) by the regulatory agency or an approved body as a condition of maintaining a licence to operate.
b) Random on-site inspections by the regulatory agency to detect any non-compliances.

A mix of the two can also be used depending on the likelihood of non-conformance and its consequences.

6.2.4 Cost recovery

Regulatory agencies may adopt the principle of cost recovery for inspection activities and this will have a significant financial impact on business, over and above the cost of compliance itself. Cost recovery can be implemented through licensing fees, registration fees, industry levies and service charges. Another mechanism is to increasingly devolve inspection, testing and certification services to the private sector.

While this can simply be seen as removing a disguised government subsidy, there are issues as to how costs are recovered. For example, the cost of sending inspectors to remote locations is normally greater than for major cities; and private inspection, testing and certification bodies will seek to factor the real costs into their charges. However, government agencies are more likely to base licensing and registration fees on factors such as number of articles produced or size of project, rather than actual costs the government agency incurs. This sort of cost-shifting may well be justified by government policies to apply charges equitably to all businesses or policies to remove obstacles to businesses providing employment in regional areas.

6.3 Implementation and enforcement

6.3.1 Enforcement policy

An important aspect of technical regulations is enforcement policy as a means of ensuring maximum compliance. It encompasses educating businesses on their legal obligations, instilling public confidence that the technical regulations are necessary and will be enforced impartially, as well as mounting prosecutions where appropriate.

The concept that a certain technical regulation is in place, therefore it will be obeyed, is overly simplistic. For a start, no government agency will have the resources to inspect every potential opportunity for non-conformance across an economy. In practice, commercial competitors are often the best ‘whistle-blowers’ when it comes to bringing non-conformances to the attention of regulatory agencies, especially when dealing with highly technical matters. This is dependent on developing a culture of compliance within an industry, such that any business not in conformance is seen as seeking an unfair advantage and bringing the industry into disrepute.

Building a culture of compliance depends heavily on how the technical regulation is enforced. If the goal of the technical regulation is to, for example, improve safety, it is important that this policy goal is carried through to enforcement. Overly pedantic enforcement of technical regulations where the spirit of the law has been met; or selective enforcement applied to some business enterprises, and not others, will lead to a lack of credibility of the regulatory system.

There will always be a small section of industry that opposes regulation on principle, often because they have had a bad experience with enforcement in the past. However, when the technical regulation is seen by the majority of businesses as irrelevant and unnecessary, there is little chance of building a culture of compliance. Sometimes, this can be addressed to some extent by ensuring an effective feedback mechanism between enforcement officers and those responsible for drafting technical regulations to identify and correct any anomalies in the technical regulations encountered during enforcement. In this context, an anomaly would be where the practical effect of enforcing the technical regulation leads to something other than correcting the market failure that it was meant to address. For example, the adoption of an international standard into a technical regulation aimed at improving product safety may be forcing additional costs onto local small businesses to the point where even those local businesses with a good safety record are put under stress.

An example would be the adoption of ISO 8124-3 *Safety of toys—Part 3: Migration of certain elements* which requires testing for heavy metals to the microgram level which normally requires sending samples for testing in Europe or the USA, where suitably accurate testing facilities are available. While heavy metals at low concentrations can still harm children, the nature of the way toys are manufactured tends to mean that heavy metals are either present in very high concentrations, such as in lead soldiers, or not at all.

6.3.2 Interpreting technical requirements from a legal perspective

Standards development bodies typically receive hundreds of requests for interpretations each year; and in many cases, the standard itself doesn't directly address the question posed, which is a frustration for an engineer trying to apply the standard to a new design. Some standards bodies provide advice about the intent of the committee that developed the standard, for example, the intent of a specific requirement was to prohibit a certain well-known practice that had proven to be unsatisfactory; but nothing more than that. This type of advice could then be extrapolated to how the requirements might be applied to a new design that the committee never envisaged. While advice like this may be of assistance to industry, the legal standing of such interpretations is questionable. In general, it is just an opinion, albeit an opinion expressed by a body with considerable expertise in the field.

Where a standard is adopted into law through a technical regulation, unless the law makes specific provision to recognise interpretations or rulings issued by the standards development body, it is the role of the courts to decide how the written words in the standard are to be interpreted. In *Australian Competition & Consumer Commission v MHG Plastic Industries Pty Ltd* [1999] Federal Court of Australia 788 (15 June 1999), the court decided to apply its own definition of the words 'rigid' and 'rigidly' as they apply to a piece of testing apparatus, rather than relying upon the expert testimony of engineers or the standards development body. Justice Emmett wrote that 'I do not consider that there is any justification for construing those terms otherwise than in accordance with their normal meaning'. This proved to be pivotal in the case as a layman's understanding of the terms was much broader than the way the standards development committee had intended.

6.3.3 Extent of legal obligation

A question that arises from time to time is the legal obligation of a business to comply with a technical regulation if a less safe condition will result.

An example is the case in Australia in the early 1970's when imperial measures were still in use. European luxury cars were being imported into Australia in small numbers at the time and there was no mutual recognition with Europe for motor vehicles. The Australian requirements for the supply of seat belts covered both seat belts fitted into new cars and replacement seat belts sold as aftermarket products. Those requirements specified a minimum width of 2 inches for the seat belt; however, the original equipment seat belts fitted to imported Mercedes Benz cars were only 50mm wide, just under 2 inches.

In order to gain approval to sell the Mercedes Benz cars in Australia, the factory-fitted inertia reel seat belts were removed and replaced with locally made 2 inch wide seat belts of a fairly basic design that had to be manually adjusted. Given that the market advantage of the German cars was, at least in part, their enhanced safety features compared to locally made cars (with their locally-made seat belts), this situation was not welcomed by the importers of European cars, who voiced their displeasure. It persisted until metric measurement was adopted in Australia in 1970.

Car importers were obliged to comply with the local technical regulation even though it may have diminished the safety outcome. They could use, as a legitimate defence in an action against them, the fact that they were obliged to follow local statutory law and the local standard. However, that defence would only extend to achieving compliance with the law, not to the means of compliance chosen. If it could have been shown that there was a safer solution, perhaps sourcing 2 inch wide inertia reel seatbelts from a third economy, then the defence of fitting basic seatbelts in order to comply with statute law would have had limited effect.

6.3.4 Prosecutions and improvement notices

The threat of prosecution is an important tool in enforcement policy, but actually mounting a prosecution is a last resort when other avenues to encourage compliance have failed.

Sustaining a conviction based on failure to comply with a standard mandated under a technical regulation is often difficult, unless there is a guilty plea. The reason is that standards tend to be written with the expectation that they will be applied by an engineer or other technical specialist. Many things are not explicitly stated in the standard on the basis that a trained technical person will only need to be given the overall parameters and their existing knowledge will cover the finer details.

It is often the case that, when viewed from the perspective of a technical person working in the field, the spirit and intent of the standard has clearly been flouted. However, to prove beyond a reasonable doubt that the letter of the standard has deliberately been contravened is much more difficult. Many decisions made by lower court judges are reversed on appeal because this legal test has not been met.

Courts can become bewildered by conflicting expert evidence from the prosecution and defence; and lower court judgements are often based on things a layman can more easily grasp. This is often the downstream effects of the non-compliance, such as the product failing in service, which may or may not have been attributable to the failure to comply with the standard.

An alternative approach to enforcement, that is only available in certain legal jurisdictions, is the issuing of an improvement notice. When an inspector detects a non-conformance with a technical regulation, the inspector issues a notice to undertake certain clearly defined improvements by a nominated date, for example replace a specific piece of equipment or have a scale recalibrated. Failure to comply with the notice is an offence in itself, which can deliver a conviction without the need to go through the difficult and expensive process of trying to prove non-compliance with the technical regulation itself.

From the perspective of business, especially small business, this approach is generally seen as more sensitive enforcement. The proprietor has been given a temporary reprieve from prosecution and can avoid prosecution altogether by undertaking the specified improvements by the due date.

6.4 Contract law

Contracts are more widespread than most people realise, for example, if a child buys sweets at the local shop, the child is entering into a contract. Even this type of verbal contract is enforceable under law. If the sweets were sold by mass, the legal metrology provisions of the law would apply to this legal contract.

Where standards normally come into play is in written contracts for the supply of goods or services. A contract for the construction of a building would normally be quite specific about the standards for materials and building methods to be followed. This would then be passed down the chain to subcontractors engaged for the project to ensure that they followed the appropriate standards.

In the case of a concrete slab, the proof strength may be specified as, say, 30MPa[1)] at 30 days when tested in accordance with a specific standard. The contract may even specify that the testing laboratory must be accredited and how any shortfalls in strength will be resolved. For example, if the concrete tests at 28MPa, there may be a monetary compensation to be paid by the subcontractor; but below 25MPa, the subcontractor may be obliged to demolish the slab and repour it. Most contracts, however, don't specify remedies; but instead nominate a neutral body to arbitrate on technical disputes, such as an association of professional engineers.

Where a dispute cannot be resolved between the parties, a party to the contract can take the matter to court and seek an order for specific performance, in other

1) The proof strength is the measure of whether or not the concrete in a building has been correctly mixed and poured. As concrete gets stronger with time, the standardised strength test is conducted on a sample, 30 days after the batch of concrete has been poured at the building site.

words, ordering the other party to comply with the contract. Failure to comply with the order would amount to contempt of court and penalties would apply.

Another way that standards figure is in disputes after a building is completed. For example, an occupant of a newly-built luxury apartment may complain about noise coming through the common wall from an adjacent apartment. After demolishing the outer covering of the common wall, it may be found that the masonry, although strong enough to meet statutory requirements, has been installed in a rough manner with some gaps that allow noise to penetrate. The subcontractor may argue that he was just asked to lay a masonry wall and that this is typical of the quality of workmanship in the industry. If no standard for the masonry work has been specified in the subcontract, the principal contractor for the construction of the apartments could be left to bear the high cost of retro-fitting a noise abatement solution and making good the demolished wall covering, not to mention any actions for damages brought by the occupants.

6.5 Common law

6.5.1 Basis of common law

The common law is unique to the English legal system and those legal systems based on the English model. It has its origins in the Middle Ages when much of the statute law, as we know it today, did not exist. It was based on determining who was at fault in a dispute and the amount of compensation to be paid rested.

Today, the same principle still applies and a person can bring an action against another person who has caused him or her damage and seek monetary compensation. Because the test in common law is that ‘on the balance of probabilities’ the party was at fault, rather than ‘beyond a reasonable doubt’, a civil action may be more likely to succeed than a criminal action if the facts are in dispute. Some highly publicised US murder cases failed in the criminal court; but were successful in the civil court, because of the different test applied.

Common law is based on precedent and there are a number of principles or Torts that have evolved over the past 500 years that establish what constitutes acceptable conduct in the eyes of a reasonable person. In the standards and conformance arena, the Tort of negligence tends to be the one most commonly applied.

6.5.2 Negligent acts

One application of the Tort of negligence is based on a person not taking reasonable precautions to prevent loss by another. A national or international standard is often used as evidence of what reasonable steps a person should take to discharge his or her duty of care to others. However, failure to comply with a standard is not, of itself, proof of negligence. There may be many reasons why it would be unreasonable to expect compliance with the standard, especially a voluntary standard, for example, the standard may not actually be widely used by the relevant industry. It may also be that the standard was not intended to be applied to the specific situation.

◄Fig. 6-1
MV *Explorer*

The 2007 sinking of the 2400-ton cruise ship MV *Explorer* after hitting an iceberg in Antarctic waters might have been prevented had the ship been subdivided in accordance with current standards which would have allowed the flooded compartments to be isolated. No lives were lost, but there were extensive property losses as the ship sank within 20 hours of becoming holed. Although designed for ice operations, and compliant with the standards applicable at the time it was built in 1969, the ship was of an old design by modern standards. Unfortunately, it is virtually impossible, and certainly uneconomic, to change the subdivision arrangements once a ship has been built and the internationally recognised standards for this aspect of the ship's design are only applicable to new ships at the design stage. Thus, to suggest negligence by the ship's owner, based on not upgrading the vessel to comply with current subdivision standards, would be an unreasonable application of those standards. However, had the number and type of lifesaving appliances not been in accordance with the latest standards, this would have been evidence of negligence as those standards are more easily applied to an existing ship.

The extensive use of the common law in North America has had some downstream effects related to standards. A business in that region that does not insure itself for negligent acts will find it difficult to engage with the wider business community, because it will be unable to pay out on any common law suits that may arise, leaving the businesses it deals with, such as suppliers and retailers, to bear the burden. Insurers, in turn, will want the business to protect itself against negligent acts before they will offer cover; and this is often achieved by requiring the business to meet all relevant standards, even if they are voluntary. It is therefore unsurprising that one of the oldest standards development bodies in the USA is Underwriters Laboratories, founded by William Henry Merrill in 1894.

In North America, there is high level of compliance with standards due largely to the downstream effects of common law, compared to say Europe, where statute law is the more important driver of compliance with standards.

6.6 Competition law

Many governments have legislation that prohibits collusive practices between businesses aimed at reducing competition in the market. This is known by many names such as competition law or anti-trust law.

At first glance, industry's role in the development of technical standards appears to be in contravention of this type of law. After all, it typically involves major industry players working together to set the minimum prerequisites for market entry and thereby, effectively setting a floor price. This influence could also be more subtle, particularly if those involved in the standardisation process set the requirements in such a way as to keep competitors' products out of the market.

It is true that standardization activities may, in certain circumstances, harm competition; however, the test of whether or not this is acceptable is if the resultant benefits in terms of preventing market failure outweigh the negative effects on the market due to a reduction in competition. In some economies, this test is effectively predetermined in the competition legislation, where the standardisation activities of certain nominated bodies are excluded from the collusion provisions. This recognises that the nominated bodies have internal processes sufficient to ensure that their standardisation activities are not misused for collusive purposes. In other economies, competition law applies equally to standardisation activities as it does to other activities by businesses and each standards development action would need to pass the test on a case by case basis.

An interesting case in this area comes from the USA: ASME vs. Hydrolevel Corp. In 1971, the engineering firm of McDonnell and Miller Inc. requested an interpretation of the ASME Boiler and Pressure Vessel (BPV) Code from the ASME Boiler and Pressure Vessel Codes Committee. Although initially undisclosed by them, McDonnell and Miller planned to use the response to their inquiry to show that a competitor, Hydrolevel Corp., was selling a boiler control device which was not in compliance with the ASME BPV Code.

T.R. Hardin, chairman of the ASME committee and an employee of the Hartford Steam Boiler Inspection and Insurance Company, wrote the original response to McDonnell and Miller's inquiry. In developing the interpretation, Hardin took advice from another ASME committee member, John James, Vice President for Research, at McDonnell and Miller who had a leading role in writing the relevant section of the BPV Code.

ASME's interpretation was then used by McDonnell and Miller salesmen as proof of Hydrolevel's non-compliance. Hydrolevel was new player in the market; and after this setback, it never acquired sufficient market penetration to sustain business, eventually going bankrupt.

As a result, Hydrolevel sued McDonnell and Miller, the Hartford Steam Boiler Inspection and Insurance Company, and ASME for restraint of trade. Hydrolevel's lawyers argued that two key ASME committee members acted not only in the self-interest of their companies, but also in violation of the Sherman Anti-Trust Act.

McDonnell and Miller and the Hartford Steam Boiler Inspection and Insurance Company settled out of court, but the litigation against ASME went all the way to the Supreme Court where, on a 6-3 decision, the Court found in favour of

Hydrolevel on the liability issue. Following a damages retrial, the case was settled for $US4.75 million in favour of Hydrolevel. A criminal trial for the anti-trust violation did not proceed, most likely because of the higher level of proof required to establish guilt.

Asia-Pacific
Economic Cooperation

Part III.

Business Strategy

APEC Sub Committee on Standards and Conformance
Education Guideline 3 – Textbook for Higher Education

Standardization :
Fundamentals, Impact, and Business Strategy

Chapter 07

Standardization and Innovation

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Learning Objectives

After completing this chapter, you should be able to:
a) Understand the relationship between standards and innovation.
b) Explore under what circumstances innovation and standards affect each other.
c) Understand how technological innovation can be encouraged and promoted when firms use standards efficiently.
d) Understand how standardized designs are selected through market competition.
e) Identify the strategic options for the standards battle for technological innovation.

Opening Case: Standard Battle between Apple Computer and Wintel PC

Computer technology consists of hardware (all the physical equipment of computers), firmware (embedded software in programmable microchips) and software (a set of instructions that tells the electronic system how to perform tasks). Published and unpublished standards and interface protocols also allow designers to make sure that hardware and software work together (Kim, 2002). An operating system (OS) for computers is one of the most important software that coordinates a computer system's components, controls processes such as scheduling computing processes, and manages the flow of data to the connected devices. For personal computers (PCs), the OS provides additional interfaces for application software. Among the major OSs for PCs are Microsoft's Windows OS and Apple's Mac OS (Wonglimpiyarat, 2005).

In launching Macintosh, Apple did not license its OS to OEM hardware suppliers. Apple thought the superiority of its technology was enough to make it a *dominant design*[1)] in the market, allowing the computer firm to gain proprietary benefits (Wonglimpiyarat, 2005). Having used "standard-based licensing to the clones," IBM was a close follower;[2)] it set a strategy for making Wintel machines based on Microsoft's OS and an Intel microprocessor.

In November 1985, Microsoft was ready to launch Microsoft Windows, a new OS that would reduce the point of differentiation of Mac OS's graphical user interface (GUI) started ahead by Apple. Microsoft also used a product bundling strategy to include application programs running on Microsoft Windows in the OEM deal, enabling smooth implementation via the standardized interface technologies (Hagedoorn, 2001). Application software developers who developed important complementary products for PC wrote application software for the bigger standardized market — i.e., the users of Wintel machines — first (Hill, 1997). Apple's "non-standardized but proprietary" strategy also failed to build fast distribution capability to disseminate the innovation to the market. Since there were more application software available for Wintel machines based on Microsoft's Windows, consumers increasingly placed greater value on Wintel machines and purchased them in larger numbers. The resulting increase in the installed base of Wintel machines relative to Apple machines further strengthened the motivation for software developers to write applications first for Wintel machines and later for Apple machines. Thus, over time, the Wintel standard pulled progressively farther ahead.

The distribution strength of global PC manufacturers and value of application programs running on Microsoft Windows enabled Microsoft Windows to enjoy wide adoption and emerge as a dominant design. Since the Wintel standard OS was

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1) In many markets, competition in the market encourages the selection of a set of key technological designs adopted by that critical mass of customers; alternative designs are forced to imitate this de facto standard or "dominant design."

2) Apple Macintosh was launched in 1984, whereas IBM's Windows-based PC was launched in 1985.

mainly used in the PCs, the Wintel standard was fixed as the dominant design for PC (Hagedoorn, 2001). The *network externality*[3)] in this mechanism also allowed Microsoft Windows to be adopted widely in the market. Microsoft was able to draw continuing competitive advantage from its ability to dominate the PC industry through the upgrading and extension of Windows standards. According to complex system theorists, in markets wherein two or more incompatible increasing return technologies compete, small changes in the initial conditions, whether the result of chance or elaborated strategy, may result in one technology gaining sufficient lead and eventually *locking in*[4)] the market by exploiting the de facto standard; other competing technologies are *locked out* in the process (Hill, 1997).

In this case study, Microsoft's pursuit of standardized licensing strategy for PC manufacturers translated into the increase in the value of Microsoft Windows for PC users, demand for its products, and growing installed base of Wintel PCs. From this case, we learn that standards can be exploited for the competition for dissemination to the market. Many case observations show that a dominant design using a standard strategy can emerge even when the dominant technology is inferior to other designs. Although there are many research works on the management of technology vis-à-vis the role of dominant designs as de facto standards in technological innovation, the role of standards, standard-setting bodies in the innovation process, and strategic options for standardization and innovation had not been fully developed. Recently, many research works have explored the interaction between standards, innovation, and intellectual property protection. In this chapter, we shall study this issue, i.e., relationships between standards and innovation.

7.1 Technological Innovation

7.1.1 Technological Innovation and Its Characteristics

To discuss innovation in this chapter, some terms and concepts need to be classified or subdivided. *Invention* is the first working model of a technological artifact (Dunphy, et al, 1996). An invention may be derived from pre-existing ideas or technologies or could be conceived independently. Examples of inventions include the first transistor or the first controlled atomic fission reaction. One definition of *innovation* is the introduction of something new, such as product (good or service) or process. The innovated product or service is considered a value-added creation of the invention for customers. This usually happens when the technology is ready to be sold commercially. Examples of innovations include a radio receiver using transistors and a power plant using nuclear fission. Technological innovation requires combining creativity with resources and expertise in related technologies to develop new products or processes.

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3) Network externality (also called network effect) is the effect wielded by one user of a good or a service on the value of that product to other people.

4) Lock-in makes a customer dependent on a vendor for products and services and unable to use another vendor without substantial switching costs.

An innovative product/process can be distinguished from previous ones by its uniqueness in form, function, or behavior. Innovation has been a major component in developing technology or advancing technology among firms. From a business perspective, technological innovations generally yield far better returns than the average return on investment in ordinary business. In fact, technological innovation is currently one of the important drivers of competitive success in many industries.

By distinguishing between the components of a product and the ways they are integrated into the system, Henderson and Clark (1990) have derived a matrix of four different types of innovation (see Table 1). Note that architecture innovation standards play an important role because *compatibility*[5] allows focusing on the core concept without modifying the surrounding architecture.

Table 7-1 ▶ Henderson and Clark's (1990) Innovation Framework

		Core concepts	
		Reinforced	Overturned
Linkages between core concepts and components	Unchanged	Incremental innovation	Modular innovation
	Changed	Architectural innovation	Radical innovation

Technological innovation can also be classified into the following three types according to the degrees of change (Dunphy, et al, 1996).

- *Continuous* innovation is the least disruptive type of innovation because it involves the introduction of a modified product/process. Such incremental change is usually the notion of low risk of minor improvements or simple adjustments in current technologies, e.g., product line extensions, new sizes, new flavors, etc.
- *Dynamically continuous* innovation is innovation that is more disruptive than evolutionary innovation but still does not alter behavior patterns. An example is the creation of a product incorporating state-of-the-art technology but having the same basic functions, such as an electric pencil sharpener or an electric toothbrush.
- *Radical* innovations require the establishment of new behavior patterns with no established precedents such as computers, photocopying, lasers, and atomic energy. Radical technologies tend to give rise to whole new industries and diffuse throughout the industrial base, whereas evolutionary innovations tend to be found in specific segments. A fundamental technology change that clearly departs from existing practices poses an unusually high risk proposition for a firm to source or to be the first to adopt.

Technological innovation processes in a company can either be *pushed* or *pulled* through development. A pushed process is based on existing or newly invented technology that the organization has access to and through which it tries to find profitable applications. A pulled process tries to find areas where customer's needs

5) Compatibility is defined as the ability of two or more systems or their components to work together without user intervention or modification.

are not met, and then directs development efforts toward finding solutions to those needs (Trott, 2005). Succeeding with either method requires an understanding of both the market and the technical problems.

7.1.2 Benefits of Technological Innovations

Technological innovation can be viewed as an integrated process of pushing the frontiers of a technology forward as well as its commercial diffusion. Technologies often exhibit increasing returns to adoption. As the technology is used, greater knowledge and understanding of the technology accrue as byproducts that may subsequently enable improvements both in the innovated technology itself and in its innovated applications. An adopted technology usually generates revenues that can be used to develop and refine its innovation further. Therefore, the more technologies are used, the more they are innovated. These reciprocal effects between the level and diffusion of a technology can trigger a self-reinforcing innovation mechanism that increases the dominance of a technology regardless of its superiority or inferiority to competing technologies (Schilling, 1999).

Teece (1986) argues that profits from innovation depend on the interaction of three families of factors: *appropriability*[6)]*regimes, complementary assets*, and presence or absence of a *dominant paradigm*. Note that appropriability conditions -- in addition to patent and copyright protection -- include secrecy, lead times, costs and time required for duplication, learning, sales, and service assets. Moreover, such appropriability regimes are largely dictated by the nature of technological knowledge. They explicitly consider how intellectual property and nature of knowledge impact appropriability and technology commercialization strategies. Teece (1986) also claims that imitability is a function of both legal impediments (patents, copyrights, trade secrets, and trademarks) and inherent replicability of the technology, which depends in part on whether the know-how is tacit or codified.

During the 1960s and 1970s, innovations were realized as a result of technology push and demand pull. Thus, deriving appropriable benefits from an innovation was the main concern of business organizations. In the mid-1980s when products emerged in the market as a sub-system of a total system rather than as standalone products, industries became aware of the strategic importance of coordinated and collaborated innovation. This new innovation model emphasizes the significant increase in the role of collaboration among sub-systematic innovations and technical standards for systematic collaboration among sub-systems. We shall study this standard issue in the next section.

6) Appropriability is defined as the quality of being imitable or reproducible; it governs an innovator's exclusive ability to capture the profits generated by an innovation.

7.2 Standards for Technological Innovation

7.2.1 Compatibility and Standard

Product compatibility is an important aspect of product design and diffusion of innovated products in markets. For example, in the computer industry, compatibility is required to ensure that hardware and software interface seamlessly. In the transportation industry, compatibility is necessary so that shipping containers can be moved with ease between railroads, ships, and trucks. In the cellular telecommunications industry, compatibility is crucial if base stations, switches, and cellular phones are to work with one another.

Compatibility is also a must if complementary products are to work well together. In industries where compatibility is important, the value of owning a product for a consumer is an increasing function of the availability of compatible products. For example, if there are neither software applications nor computer peripherals such as modems and printers available for a PC, the value of the machine to the average user will be very low. The greater the availability of software applications and peripherals to be connected is, the more the consumer can do with his/her computer, and the greater the value he/she derives from it. The availability of compatible products is determined by the installed base of the given product.

Compatibility is normally maintained by establishing and using *a common technological standard* (Hill, 1997). For example, in the PC industry, these standards are set around OSs and interface between hardware components. In the railroad industry, compatibility can be maintained by adhering to a common set of dimensions for the width of the rail and a common size of shipping containers for transportation. Compatibility may be implemented by *standardized interface*, which defines the rules of exchange; thus allowing even highly disparate technologies to be compatible provided they conform to the interface. In this type of standards, process and performance need not be explicitly determined; instead, a fixed format for the interface is specified. The goal of this type of standard is to ensure smooth operation between systems using the same physical entity or data. An example of this type of standard is computer-aided design (CAD). CAD software in general does not use the same format for data input and output; through the creation of generic formats and standards such as the STEP (Standard for the Exchange of Product model data), however, engineers and designers are able to create and exchange their geometric models using different CAD software (Hill, 1997).

7.2.2 Standard and Its Characteristics

As the best known international organization for standardization, the International Organization for Standardization (ISO) uses the following official definition of a standard: “a document established by consensus and approved by a recognized body, it 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 Guide 2004). Note, however, that this definition fits only the *de jure* standard but excludes the *de facto* standards that have been widely accepted yet lack formal approval by a recognized standards body (Allen, 2000). De jure standards are promoted by private authorities or promulgated by official regulatory agencies such as a government or a domestic or an international standard body such as ISO. On the other hand, de facto standards are widely accepted and used in the market but do not need formal approval from recognized standards organization(s). In general, the de facto standard is the result of a widespread consensus on a particular product or protocol with a large market share. Examples of de facto standards in today's computer market are the QWERTY keyboard layout and the Wintel PC architecture. To include the de facto standards, a more complete definition of the standard would be "a limited set of solutions to actual or potential matching problems directed at benefits for the party (or parties) involved, balancing their needs and intending and expecting these solutions to be used repeatedly or continuously during a certain period by a substantial number of parties for whom they are meant" (de Vries, 1997).

According to Wang (2007), de facto standards voluntarily arise from the market order, which includes modes such as *market selection*, *negotiated selection*, and *hybrid selection modes*.

- In market selection mode, the product market determines the evolution (dominance or obsolescence) of incompatible standards.
- In negotiated selection mode, to avoid a standards battle in the market, firms need to coordinate the development and introduction of a standard; they may form a forum or a consortium for this purpose.

In a competitive market, firms wishing to establish their technology as the standard adopt strategic options such as entering into strategic alliances and adopting appropriate positioning strategies.

A system of IPRs (such as patents) is often necessary to ensure that individuals or companies carry out innovative activities. Without IPRs to knowledge resulting from an invention, imitation (e.g., through the reverse engineering of products) will eat into the inventor's profit rate; hence the lower incentive to engage in inventive activities. On the surface, standardization and IPRs may serve conflicting interests, i.e., an IPR is aimed at the appropriation of a right to exploit a piece of knowledge by a single firm, whereas a standard seeks to identify a common pool of knowledge to be used by all parties contributing to or using the standard. Innovations protected by IPRs have clear positive impacts on the performance of a company, but they restrict other companies from using the protected technologies. Technical standards are generally public goods. Whereas de facto standards can be protected by IPRs, the technical specifications described by de jure standards published by accredited standardization bodies can be used by every producer as a rule. Therefore, goods relying on these kinds of standards may be produced even in regions that are not the original source of innovation (Bekkers, 2002). In other words, standards and IPRs do not necessarily run counter to each other.

7.2.3 Standard Architectures vs. Values of Innovation

In some cases, standards can be a major platform for innovation but become a strong constraint for innovation in other cases. In other words, standards may have positive or negative impacts on technological innovation processes. The following are a standard's positive impacts on innovation as reported in literature:

- Economies of scale: Standards allow firms to invest in mass production.
- Shorter time to market and reduced R&D costs: Using standardized technology and features can improve R&D efficiency.
- Network effects: In many markets, the decisions of some consumers can affect the utility derived from a product by other consumers. The size of a compatible network makes technology more useful and effective (e.g., telephone, email).
- Indirect network effects: The number of complementary products/services increases the benefits of a technology (e.g. software for PC, compact disks for the CD player).
- Fast technology adoption: The setting of standards is a major force in expediting the diffusion of innovation by reducing user uncertainties regarding the innovations as well as how they work.
- Learning effects: Customers need to know only one technology through "learning by using" (e.g., Microsoft Windows).
- Focusing on other competency: Standards allow firms to focus on complementary products or interconnections, thereby realizing cost savings for users and interchangeability among suppliers.
- Minimum quality and safety: Standards guarantee minimum quality and restrict the negative externalities[7)] that can be damaging to the health or environment.
- Increased variety: Standardized interfaces allow for modular innovations (e.g., audio component system).
- Lowering the entry barriers: Standards can lower the entry barriers for new players because the interoperability and exchangeability issues have been resolved by the standards.

The following are a standard's negative impacts on innovation as reported in literature:

- Narrowing the technological choices: Mass production can reduce variety (e.g., only black was allowed as the color for Ford's Model-T sedan).
- Diminishing innovativeness: Future innovations by newcomers may be hampered since the incumbent innovation becomes a dominant design.
- Compromise with low quality: Too restrictive quality and safety standards hinder the development of markets. As a result, the producer of some goods may take advantage of low-quality standards.
- Decrease in profits from innovation: Standards can make collecting rent from

7) A negative externality is an action of a product on consumers, wielding a negative effect on a third party. Many negative externalities are related to the environmental consequences of production and use.

innovation difficult because returns are shared with other players in the market.

- Restricted diffusion of technology: In case of proprietary standards, other players of the industry cannot contribute to the innovation and diffusion process of the technology.
- Monopoly effects: Misuse of technology by small groups of suppliers to raise rivals' costs, allowing them to behave like monopolists
- Consumer's wait-and-see stance: Consumers may not want to be saddled with an installed base that offers the limited benefits of a too-early standard setting. For example, the battle brewing on the UNIX standards in the 1990s in the computer industry illustrated the market's reluctance to adopt until the standards were clarified.
- Switching costs: Standard setting sometimes makes firms hold on to an innovation and stifles further innovation.

7.2.4 Standards and Market Competition

Even if a standard-setting body agrees on a standard, not all standards become winners in the market. Early and sizable investment is necessary to try and get a standard to be accepted in the market. Even after an innovation has occurred, there is no guarantee of its success or of the innovation being accepted by the market. Innovated products often remain commercial failures. In some ways, competition for the market becomes a competition to "own" the standard (Teece, 2006). Competition for the future often involves competition to establish new standards for the interworking of products and services supplied by a number of different vendors. In other words, it is an inter-specific competition wherein one competitor influences the growth rate of the other (Wonglimpiyarat, 2005). Whenever a new generation of standards is defined, a new market is created; thus giving an opportunity for new players to enter the market and emerge as major players in the new generation of systems. The incumbent players in the old market face the challenge of being locked into the legacy systems they have invested in; thus, the standardization of a new generation of systems renders dynamism to the market (Kano, 2000).

With regard to de jure standardization, competition may take place in the standards committee prior to standard setting, not in the market. Competition will take place between standard-conforming implementations after the standard setting, not between two different de jure standards. The agreed-upon standardization generally represents a compromise between the different players in the market. No one will be completely satisfied with the standardized results, but a level playing field for all players in the market is created by these standard settings. Better price and performance as well as a large variety of products can be realized by the standards. Thus, de jure standards can be a platform for innovation.

A large *installed base* may serve as an entry barrier to other incompatible systems, thereby creating a tendency for sustained market dominance. Both incentives and ability to deter other incompatible systems are positively correlated with the size of the installed base. The incumbent may have inefficiently huge incentives to innovate. Note that it is not only the quantity of innovation that matters but also the quality. In particular, the quality of innovation may improve considerably when the dominant firm makes its decisions on the basis of economic efficiency, not in an attempt to maintain its market power. On the other hand, reduced competition due to incompatibility removes the incentives for entrants to innovate and produce differentiated but compatible products, since producing a better product may not suffice to attract consumers (Bourreau, 2001).

7.3 Technological Innovation Using Standards

7.3.1 Standard as a Baseline for Innovation

A standard can be the baseline for any innovation. Standards are the consequence of a previous innovation as well as the ground for the next one. The early standardization of products may encourage innovation in complementary technology and organizations and may promote subsequent incremental innovation designed to perfect the original technology.

By definition, innovation is dynamic; standards control the dynamics of the innovation. Dynamic standardization is an important enabler of innovation. Such dynamism occurs in different ways (Commission of European Communities, 2008).

- Standards that express "state-of-the-art" give innovators a level playing field facilitating interoperability and competition between new and already existing products, services, and processes. Standards allow customers to place their trust in the safety and performance of new products and enable the differentiation of products by referencing standardized methods.
- The development of new standards should also accompany the emergence of new markets and introduction of complex systems such as the expansion of the Internet.
- The use of standards contributes to diffusing knowledge and facilitating the application of technology; this may then trigger innovation particularly non-technological innovation in the service sector.

Standardization is a voluntary cooperation among the industry, consumers, public authorities, and other interested parties for the development of technical specifications based on consensus. Standardization complements market-based competition typically to achieve objectives such as the interoperability of complementary products/services and to agree on test methods. As technologies are innovated, standards are also required to ensure the performance, conformity, and safety of new products and processes (Allen, 2000). By providing information-hiding capacity, a standard interface allows a firm to make its technology compatible with that of other producers while still concealing the mechanics of its core functionality (Schilling, 1999). Since all types of technical standards codify technological know-how, such codified technological know-how can be easily distributed among different companies or even the entire industry. Whereas innovations protected by intellectual property rights restrict others from using the technologies covered, technical standards are generally public goods as well as a form of technical infrastructure. The faster and greater the diffusion of private technological know-how by technical standards is, the bigger the pool of such publicly available information and the stronger its impact on growth (Blind, 2008).

An important role of standardization is to synchronize disjointed technical innovations into a systemic innovation that creates a new market. To explain the relationship between standard and systematic innovation, we can classify innovation as follows (Kano, 2000):

- *Systemic innovation* is one wherein an overall system framework is innovated at certain intervals through standardization processes as successive generations of standards. From the viewpoint of standardization, a systemic innovation requires a new standard -- whether de jure or de facto -- defining the overall framework of a new system accompanied by a new set of interface specifications among sub-systems. These standards are made through cooperation -- not only among those complementing each other such as manufacturers of different sub-systems but also among potential competitors such as manufacturers of the same sub-system -- for the collective creation of a new market and to build it as quickly as possible. Systemic innovation examples are the successive generations of 1G, 2G, and 3G mobile communication systems, each of which required a new standard. Other forms of systemic innovations made through standardization are closed de facto standardization led by a single company or sometimes in consultation with its close collaborators (e.g., Windows OSs by Microsoft), open de facto standardization by industry forums, or emerging open de facto standardization through the use of the Internet.
- *Standalone innovations* are made in various sub-systems independently and incessantly by competitors. According to Teece (1998), a standalone innovation is one that can be introduced without modifying other sub-systems. Examples are the cost and size reduction of mobile phones and improvements in their design, performance, and functions including prolonging their battery lifetime. Standalone innovations are performed independently and incessantly by competitors in the market to differentiate their products within the framework of an overall system standard.

In the mid-1980s, many products started to emerge in the market as sub-systems of a larger total system rather than as standalone equipment. Examples were analog mobile phone systems, computer software packages, and peripheral equipment for PC such as printers. These were all products that were sub-systems of a total system rather than standalone products. Such high integration of functions -- coupled with the progress in information and telecom technologies -- enabled products to be interconnected with each other to make a total system, offering a whole range of new functions that could not be offered by standalone products. Examples are mobile phone services and Internet applications (including email and world wide web (WWW)). Since each sub-system generally requires totally different technical and business skills, it has become increasingly inefficient for a single company to cover and excel in all sub-systems; thus naturally leading to vertical specialization in an industry. Thus, standards, which were de jure or de facto, became important in terms of specifying the overall system framework and the interface specifications to interconnect sub-systems. Once such standards exist, then sub-system products can innovate independently to differentiate themselves in terms of cost, design, performance, and functions to compete in the market as long as they comply with the interface specifications with other sub-systems (Kano, 2000). An important role of standardization in these modern innovative processes is coordinating the various ripples of technical innovations performed independently by specialist companies and synchronizing them into a wave of creative destruction by providing an overall system framework. Thus, these disjointed innovations can work together in a systemic way to offer a useful service to the end user or to create a new market.

In a company, standardization can be used in two ways. *Ex post* standardization is a standardization process wherein the market or an organization chooses between different existing products or technologies in hindsight. *Ex ante* standardization is a standardization process wherein a company pools its resources to create new products and services efficiently. Participation in standardization can expand a firm's internal research and development process; in many cases, it is a vital part of the product development cycle and innovation in the firm. In particular, ex ante standards can define the future capabilities for information and communications technologies in contrast to recording and stabilizing existing practices or capabilities de facto (Lyytinen, et al, 2008). Ex ante standardization is a collaborative effort to create technologies or services that do not yet exist. The participants bring with them their knowledge, R&D capabilities, and intellectual property. Together, they create specifications for new technologies, services, procedures, systems, or architectures. These specifications become available for all participants, and they can use such to create new innovations. The specifications themselves are also innovations. The standardization process is no longer a choice between existing technologies; rather, it has become an innovation process wherein new technologies, services, procedures, systems, or architectures are created from the different parts brought into the process by each participant (Grøtnes, 2008).

7.3.2 Standards for Innovation Promotion by the Government

The traditional explanations as to why the government intervenes in the standard-setting process are "standards as public goods," "structural inertia," "systemic failure," "anticipatory myopia," and "market failure." (Wang, 2007). Recently, views on government intervention in standardization may yield positive economic benefits to society should be balanced with the counter case. Governmental standard setting may induce competition between rivals in the private sector, and this in turn can fast track technology innovation. For example, to deploy 2G cellular telecommunication services in Korea, the Korean government had played an assertive role in the standard setting of 2G technologies. Government intervention in standardization may also generate economic costs associated with unnecessary or discriminatory technical barriers to trade, and promote dead weight losses caused by rent seeking behavior of domestic firms. The government may affect standard processes in several ways: (1) by procuring the products; (2) by conducting or investing in research; (3) by seeding the development of resources or services;

(4) by mediating in private sector competition through regulation, and; (5) by consolidating various interests and facilitating cooperation (Wang, 2007).

Research Summary: De jure standard and government's role in innovation (Bourreau, 2001)

Under the de jure standard-setting process, the government can use standard policies to minimize the confusion and cost arising from a voluntary negotiation process; thus facilitating technology innovation. There may be a social trade between innovation by incumbents and innovation by new entrants as follows:

- Ex post control mechanisms are expected to provide better incentives for innovations, at least to the incumbent firm. Indeed, the delays caused by ex ante regulation hinder incentives for the incumbent to introduce innovative services by facilitating imitation by rival firms. As for new entrants, their incentives to innovate may be stronger under asymmetric innovation. Regulatory measures may be desirable when the innovation is subject to high uncertainty and/or is expensive to adopt but at the same time easy to imitate. As such, the absence of restrictions on the incumbent firm would not encourage firms to innovate.
- The entering firm may apply competitive pressure on the incumbent firm so that prices go down and incentives for cost reduction assume greater significance. Regulation may induce the incumbent to pursue a more aggressive strategy in relation to innovation since this may be the only strategic choice left for the firm. Still, such may very well reduce the incentives of the incumbent firm to innovate by decreasing the opportunities to extract benefits from its innovation.
- As to the entrant's incentives to innovate, a similar indeterminacy prevails but for different reasons. Whether its incentives to innovate would be expanded or reduced would depend on the particular type of regulation and possibilities of imitation. Note, however, that delays created by ex ante regulatory intervention have a relatively straightforward effect on incentives for innovation. These delays are due to the assessment of new products and services to be introduced by the incumbent. In most economies, the incumbent should -- under given conditions -- present new retail tariffs to the regulatory authorities before they are introduced to the market.

With modern economies continuing to evolve and governments making innovation a primary economic virtue, technical standards and property rights have been placed under closer policy scrutiny (Drahos, 2004). The government also works with the private sector, voluntary standards organizations, or companies to advance a national strategy for effectively promoting certain technology as the basis for international standards and to lower the trade barriers in certain areas.

7.4 Standards Battle in Technological Innovation

7.4.1 Standards and Dominant Design

A *standards battle* is defined as a competition to offer a particular version of available technology, facilitating a competing innovation in the market to select a dominant design. In this chapter, we consider a dominant design a "*de facto* *standardized design*" that came from broader appeal for customers and broader market share for the innovated and imitating company as a de facto standard through competition. Note that this standard is neither de jure nor static standard.

The emergence of a dominant design in an industry would lead to a "regime switch" or an "inflexion point." As designs stabilize, the terms of competition would change from features to price. The importance of investing to support the dominant design stemmed from the need to capture customers early and to realize economies of scale. The first-mover advantage, if any, would not even begin until the market or some standard-setting body anoints a particular design as the standard.

Research Summary: Dynamic Model of Innovation

A dynamic model of the technological innovation by Utterback and Abernathy (1975) identifies two phases of innovations: *fluid phase* and *specific phase*. In the fluid phase, there is considerable uncertainty regarding the technology and its market; firms experiment with different product designs during this phase. A great number of changes (product innovation) take place simultaneously, and outcomes may vary considerably. After this phase is a de facto standard called dominant design, which emerges when a critical mass of consumers have adopted it or when a critical mass of key players in the market believe that the standard will be adopted. After a dominant design emerges, the specific phase begins wherein firms focus on incremental improvements in the design and manufacturing efficiency. At the specific phase, competition will shift from differentiation to product performance and cost efficiency. At the specific phase, innovation is also limited to product improvements that enhance standards, to manufacturing improvements, and to marketing and distribution improvements.

Anderson and Tushman (1990) developed this theory as a cyclic form wherein technological change proceeds cyclically. Each discontinuity gives rise to a period of turbulence and uncertainty (so-called *era of ferment*) until a dominant design is selected, ushering in the *era of incremental change*. In the era of ferment, design competitions and substitution take place until a dominant design is selected. After a dominant design is set, the era of incremental change starts. During the era of incremental change, elaboration of dominant design is attempted. Note, however, that a new technological innovation breaks this equilibrium by causing technological discontinuity. New products that undermine the market standard emerge victorious.

Abernathy (1978) and Abernathy and Utterback (1978) pioneered the concept of dominant design and coined many related definitions. These authors view a dominant design as the turning point that leads the industry to move from a system of "made-to-order" products to a standardized, mass-manufacturing system of a complex assembled product. According to Abernathy (1978), such transition from flexible to specialized production processes is marked by the following series of steps:

- First is the development of a model with broader appeal in contrast to the design of earlier product variants focusing on performance dimensions valued only by a small number of users. This design – which can satisfy the needs of a broad class of users -- is seen not as a radical innovation but as a creative synthesis of innovations introduced independently in earlier products.
- The second step is the achievement of a dominant product design, one that

attracts a significant market share and forces imitative competition design reaction.

- In the third step, competitors are forced to imitate this broadly appealing design (or to exit from the product market as an alternative); thus inducing product standardization throughout the industry.

Research Summary: Different views on dominant design

According to Abernathy (1978), a dominant design is one that diffuses almost completely throughout the industry.

Utterback and colleagues (Utterback and Suarez, 1993; Suarez and Utterback, 1995) define a dominant design or a "de facto" standard as one that competitors and innovators must adhere to if they hope to capture a significant market share. They have also emphasized that the emergence of a dominant design is a prerequisite for one particular design to secure a dominant market position.

Anderson and Tushman (1990) define a dominant design as "a single configuration or a narrow range of configurations accounting for over 50% of new product sales or new process installations and maintaining a 50% market share for at least 4 years." According to them, that a dominant design can only be known in retrospect, not in real time.

For Henderson and Clark (1990), a dominant design is characterized both by a set of core design concepts embodied in components corresponding to the major functions performed by the product and by a product architecture that defines the ways by which these components are integrated.

7.4.2 Causal Logics for Dominant Design

Scholars of technology management have studied a variety of underlying causal logics to explain why a particular design approach instead of others emerges as the dominant design. These can be classified into the following four types (Murmann, 2006; Teece, 2006).

- A dominant design becomes dominant because it demonstrates the best technological performance among the different functional characteristics of the technology. Thus, such special design makes all other producers imitate the design if they want to secure enough market shares. In this type of explanation, a dominant design settles debates among designers; the search for improvement of a technology is then started by the dominant design.
- The second group of researchers believes that the emergence of a dominant design is mainly attributed to the economies of scale and network externalities[8] that can be realized with standardized products as a strong force behind the selection of a particular design as the dominant one. Based on this economic

8) The concept of network externalities describes a situation wherein the value of adopting a particular technology depends on the number of users who have purchased a compatible product. Telephone systems, railroads, VCRs, and computer platforms are all examples wherein users have a strong incentive to adopt the technology that is already adopted by many other users because the larger network will make the particular technology more valuable to the individual user.

logic, the design that initially gains the lead in terms of market share among many competing designs will emerge as the dominant design. In this type of explanation, a first-mover advantage is usually observed in the dominant design because a first mover gets many advantages and realizes economies of scale and network externalities in the process.

- Firms often realize that the design initially gaining the lead in terms of market share will often become the dominant design due to the self-reinforcing processes. There are scholars who emphasize strategic maneuvering on the part of firms as explanation for the emergence of particular dominant designs. These strategies include coalitions, R&D collaborations, pricing, and licensing. For example, the strategy of licensing its VHS design to many other electronics companies by JVC is the main reason the JVC group was able to beat Sony's Betamax design even as Sony had been the first to market and had shown better technological performance. In the strategic maneuvering type of explanation, a dominant design is treated more as a consequence than a cause.
- The last line of research emphasizes that the multi-aspects and high development costs of many complex products make dominant designs being selected through market competition less probable. Scholars in this school contend that dominant designs emerge through a combination of economic, sociological, political, and organizational dynamics. For nuclear power plants, machine tools, electricity networks, radio transmitters, and flight simulators, dominant designs emerged through negotiations involving a diverse set of players in the market. These economic, sociological, and political differences in the institutional environments of the US, European economies, and Asia affected the technological and industrial dynamics and showed different results for the dominant designs in each region. Note, however, that the causality of this type is not easy to identify since the actors in these processes are often already attuned to the technological tradeoffs and embedded in different candidate designs.

Research Summary: Strategy for standards battle (Schilling, 1999)

To become a dominant design, many strategic issues are critical in the standards battle. Schilling suggests the following strategy considering the innovativeness of the technology and market conditions:

- Only if there are few competitors and an existing range of complementary goods and/or if the technology has a great margin of improvement (perceived or realized) over other options can a firm consider protecting the proprietary elements of its technology and still hope to secure a sufficient installed base to avoid lockout under conditions of strong network externalities. If the margin of improvement is very great, the technology may be selected as a dominant design even if the associated costs are higher.
- If the margin of improvement is great, but not that great to become a dominant design despite the higher costs, the technology may still persist as a niche solution.
- In either case, the firm must be very careful in assessing the balance between the technology's margin of improvement and the installed base advantages of diffusing the technology.

7.4.3 Strategic Options for Technological Innovation and Standards

The winner of a standards battle is not necessarily technologically superior or the most efficient firm. To be successful in innovation and to become a dominant design, firms need to consider carefully the many different aspects and design and implement business and technological strategies.

When a market is still in the process of selecting a dominant design, many alternative technologies are competing and making themselves available for selection. In this stage, a firm can develop and diffuse its technology through licensing arrangements and open its innovation systems. Protecting the technology with appropriability mechanisms (e.g., patents, keeping the technology confidential, etc.) will slow down the technology's development and diffusion in the market (Schilling, 1999). A firm supporting a technology that is not chosen as the dominant design may be forced to adopt the dominant technology, thereby forfeiting the capital, learning, and brand equity invested in its original technology. Worse, a firm may find itself locked out of the market completely if it is unable to subscribe to the dominant technology.

Fast entry into the market can give many advantages in entitling a dominant design. A firm may also increase the size of the installed base through aggressive promotion and penetration pricing. In fact, the firm may be able to influence consumers' perception of the existing installed base of the technology (through "*vaporware*,"[9] for example); thus increasing the likelihood of consumers choosing that technology (Schilling, 1999). As a technology is adopted more widely, complementary assets specialized to operate with the technology are often developed.

The size of the installed base may influence a technology's likelihood of adoption as a dominant standard. The size of the installed base (or even the perceived size thereof) may serve as a signal to consumers regarding the quality or value of a good when those attributes are uncertain or difficult for the consumer to measure[10]. For many products, the actual mechanics of the product are nearly impossible for consumers to observe and evaluate. Furthermore, even though the consumer may be able to observe the quality or functionality of the product through use, extended use or training on the product may be required before the consumer can judge the product's performance. After spending the necessary time or money in gaining the required familiarity with the product, the consumer may incur switching costs and show reluctance to try another product even if he/she has judged the current product to be of poor quality (Schilling, 1999).

When its technology is chosen as a dominant design, a firm is in a good position to shape the evolution of the industry, greatly influencing the new products of the firm. Only some innovative products can become the dominant design as the choice

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9) Vaporware is a product -- usually software -- that has been announced by a developer during or before its development if there is significant doubt as to whether the product will actually be released.

10) This is called a signaling effect.

of the critical mass in the market. If its own innovative technology is chosen as a dominant design, and it is able to protect the technology, the firm may be able to earn near-monopoly rents. Note, however, that protecting a technology can also cost a lot or decrease the likelihood of such technology being chosen as a dominant design.

There are several strategic options for a firm to entitle a dominant design according to literature:

- **Using path dependency**: Technology trajectories — the path a technology takes in the course of its evolution — are often characterized by "path dependency."[11] Although the technology's quality and technical advantage are very important, other factors that are unrelated to the technical qualities may also play important roles. For instance, time to market is crucial; early technology offerings can become so entrenched that subsequent technologies -- even if they are considered technically superior -- may be unable to gain a foothold in the market. How and by whom the technology is sponsored may also impact the adoption of the technology (Schilling, 1999).
- **Change the future technology trajectory**: One important way of disrupting compatibility is *predatory product innovation*. Church and Ware (1998) define predatory product innovation as changing the design attributes or interfaces in the system to make third-party complementary components incompatible. It may take place either by introducing a closed system and keeping it closed or by introducing an open system that allows second-sourcing, third-party provision of complementary products but subsequently leaving out producers of complementary products (Bourreau, 2001).
- **Diversified strategy**: Diversification into products or complementary products has been observed in a number of occasions. For example, Apple Computer was saved from possible extinction in the mid-1980s by the widespread adoption of Macintosh technology in the desktop publishing business. Apple did not produce all of the relevant complementary products; Aldus and Adobe supplied the critical desktop publishing software applications. Nonetheless, it did produce one important complementary product: the Apple laser jet, which was critical to market acceptance in this segment (Hill, 1997).
- **Modular and interface strategy**: An option combining much of the compatibility of open systems with the appropriability of proprietary systems involves employing a modular design. Modular product systems can utilize proprietary technology within the components of the system but use a standards-based interface to interact with other components or systems. For instance, a minicomputer's main functionality may be based on proprietary technology, but the minicomputer may also provide standards-based input/output mechanisms so that the minicomputer can be mixed and matched with other components.
- **Collaboration with partners**: A firm may collaborate with its partners and

11) Path dependency means that relatively small historical events may wield great impact on the final outcome.

providers for fast launch using standards. Specifically, the firm can use inter-organizational linkages with distributors, complementary goods producers, or customers of its technology (perhaps even pressuring suppliers or distributors to support the technology) to gain an advantage in quickly establishing an installed base or increasing the availability of complementary goods. Coalitions may emerge and shift as partner groups of companies adopt and promote standardized technology platforms. Firms sponsoring a particular technology usually have considerable investment in the design, so they have keen interest in supporting a technology that they believe has a good chance of becoming the dominant design. If the firms gain a controlling share of the market through this collaboration, they lock out alternative technologies (Schilling, 1999).

- **Licensing (and OEM) agreements with competitors**: Building an installed base may be facilitated if the sponsoring firm licenses its technology to other firms in the industry including potential or current competitors. Such may allow the partner firm to act as original equipment manufacturer (OEM) for the other firm. For example, Matsushita followed this strategy to maximize the rate of adoption of its VHS videocassette format. It aggressively licensed the VHS format to other consumer electronics enterprises including Hitachi, Sharp, Mitsubishi, and Philips NV, which then produced their own VHS-format videocassette recorders and tapes. Matsushita also entered into OEM arrangements with GE, RCA, and Zenith. Even so, Matsushita continued to compete against these companies in the final market (Hill, 1997).
- **Enhancing complementary partners**: Enterprises are more likely to invest in the development of complementary products if substantial volumes of such are needed to support the target technology. The establishment of a number of licensing and OEM agreements can help shape expectations and send a signal, i.e., that complementary assets are being built. In turn, any increase in the initial supply of complementary products can help jumpstart an increasing returns mechanism (Hill, 1997).
- **Following the dominant design by surrendering one's own innovation**: Once a dominant design has been selected by the market, firms offering technologies that are incompatible with the dominant design may surrender their proprietary technologies and switch to the dominant technology. In doing so, they may give up much of the appropriability of their technology and have little control over its future evolution. Note, however, that they can participate along with majority of the market players.
- **Contracts, alliances, and joint ventures**: Through contractual arrangements with universities or government agencies, a firm can ensure that its technology is used in exchange for price discounts, special service contracts, advertising assistance, or other inducements. For example, Microsoft used an exclusive contract arrangement to build its installed base of Internet Explorer. By the time Microsoft entered the web-based software business, Netscape Navigator already had a considerable installed base lead. To catch up, Microsoft signed an exclusive contract with online service provider America Online to deploy its own web browser -- Internet Explorer -- rapidly (Schilling, 1999).

Questions

1) What are the characteristics of technological innovation in terms of linkages between core concepts and components?
2) Explain the circumstances under which innovation and standards affect each other.
3) Discuss how technological innovation can be encouraged and promoted when firms use standards.
4) Explain the two phases of innovations by describing the emergence of dominant designs and change of innovation types.
5) Discuss how standardized designs are selected through market competition.
6) Identify the strategic options for the standards battle for technological innovation.

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Chapter 08

Competitive Strategy

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Learning Objectives

After completing this chapter, you should be able to:
a) Understand how standardization affects market expansion.
b) Explain how a differentiation strategy could be pursued in standardized areas.
c) Understand the strategy of standardization leader firms.
d) Understand the follower strategy in standardized areas.

Opening Case: DVD-ROM Standardization Process[1)]

When DVD was first introduced, it was supposed to wield great impact not only on the electronics industry but also on the information industry and motion picture industry. There are some variations of the term DVD, describing the way data is stored: DVD-ROM, DVD-R, DVD+R, DVD-RW, DVD+RW, and DVD-RAM. Home appliance manufacturers devoted their resources to develop a DVD that was supposed to be a new source of their revenue. Unlike laser disk and CD, DVD offers features such as more than 2 hours' recording time with high-quality digital video, both wide screen and standard screen supported, and Dolby AC-3 (or MPEG-2 audio) used. Just as CD had replaced LP in the audio market, DVD was expected to replace VCR in the video market. The motion picture industry and computer industry expected DVD to contribute significantly to their development. In particular, the motion picture industry had actively provided DVD titles, and the PC industry had employed the DVD drive instead of the CD-ROM drive.

The DVD-ROM standardization process had given rise to intense competition in the home appliance industry and computer industry from the start of 1993 to the end of 1995. The competition was between MMCD (Multi-Media Compact Disc) led by Sony and Philips and SD (Super-Density) led by Toshiba, Matsushita, Hitachi, Thomson, Time Warner, and MCA. Sony and Philips decided to develop the DVD based on CD technology so that the DVD and the CD were compatible; this way, the existing production technology can be utilized, and licensing fees can be secured by CD technology developers. They produced a trial product in October 1994 earlier than the allies of Toshiba. Note, however, that the motion picture industry in the USA criticized the DVD from Sony and Philips, i.e., it was not appropriate for the next generation of storage media since a motion picture with 2 hours' running time did not fit in a single disc. Since Sony and Philips believed that their DVD was good enough if it could replace the music CD and computer CD-ROM, they did not accept the criticism from the motion picture industry.

Toshiba tried to develop a DVD that could support high-quality picture and surround audio system while maintaining the same small size as that of the CD by incorporating the suggestions of Time Warner. The main concern of Toshiba at that time was whether it could have the backing of consumers. After the completion of development of the basic technology, Toshiba had adjusted its technology to meet the needs of consumers; thus gaining the support of not only the American motion picture industry but also the Japanese and European home appliance industries. In January 1995, it was announced that 7 firms -- Toshiba, Matsushita, Pioneer, Hitachi, Thomson, Time Warner, and MCA -- would suggest the Super-Density Disc as a DVD standard.

Matsushita had played an important role during the competition between the two groups. At first, Matsushita participated in the group of Sony and Philips, suggesting its technology for storing motion pictures. Matsushita realized that the DVD market was not attractive without the feature of storing motion pictures, and that the

1) This case was restructured based on the articles of Dranove and Gandal (2003) and Yoo (1997).

technology of Sony was not appropriate for that purpose. With Sony rejecting the suggestion of Matsushita, however, Matsushita broke away from the group of Sony and Philips and defected to the group led by Toshiba.

Since the two incompatible products were announced in the market even before their actual production, a cutthroat competition seemed inevitable. The Toshiba group was very confident of winning over Sony and Philips because of the support of the motion picture industry and the defection of Matsushita to their group. Thus, they suggested negotiating on standardization to Sony and Philips for the following reasons: first, to avoid excessive competition, and; to incorporate with Sony and Philips, which had so many patents on the CD technology, for backward compatibility with the CD. Yielding to great pressure from the information industry including IBM and the motion picture industry to unify the standard, both groups reached an agreement on a single standard in September 1995.

The development of the DVD standard was strongly backed by the motion picture industry since the success of the media in delivering contents could not be ensured without support from the motion picture and audio industries. Time Warner and 6 other large film companies in the United States formed an advisory group to prevent too many technology standards from emerging in the market and to avoid causing confusion among consumers due to the incompatible technologies. With Matsushita joining them, the Toshiba group won the support of the advisory group.

The computer industry also applied great pressure to come up with a single DVD standard since the DVD-ROM was supposed to replace the CD-ROM. With the increasingly fierce competition between the two groups, the computer industry was worried that the market would be divided into two incompatible DVD technologies. The technical working group of the computer industry with the participation of IBM, MS, Apple, Compaq, and HP suggested some requirements reflective of the needs of the industry for the DVD standard.

Nine firms -- Toshiba, Matsushita, Pioneer, Hitachi, Mitsubishi, JVC, Sony, Thomson, and Philips -- were involved in the development of the final draft. In the end, the video and audio specifications were mostly similar to Toshiba's technologies.

8.1 Market, Strategy, and Standardization

The implications of the DVD-ROM standardization process are as follows: first, standardization competition may hinder the growth of the market; second, the content-providing business wields great impact on the standardization process of the media industry. Since compatibility is a very important factor when consumers decide to purchase a network product, continuing competition between incompatible technologies makes consumers hesitate making a purchasing decision. Likewise, fierce competition will reduce the potential benefits that can be derived by consumers in the monopolized market. In the case of the DVD standardization process, competitors made an agreement on a single standard for the abovementioned reasons. The success of a network product can be guaranteed with the consensus of related industries. In the case of DVD, Toshiba gained the support of the motion picture industry by incorporating its suggestions. In contrast, Sony and Philips relied solely on their superior technological capability without listening to the voice of related industries. The success of Toshiba was mainly attributable to the support of the contents providers.

The opening case shows some important features of standardization strategies such as the impacts of the standardization battle on market growth, importance of network externalities in consumer choice, competition between allies of standardization groups, importance of complementary markets during the standardization process, etc. In this section, basic concepts that are needed in understanding the standardization strategy in the product market are discussed.

8.1.1 Network Externalities

The current world economy can be characterized by two important trends: globalization and information technology. Thanks to these trends, product markets in today's businesses show rapid technological changes and innovations. The convergence of technology is another factor to be considered in the new economy, which is sometimes called network economy wherein economies of scale depend on the size of the network.

The size of the network has a strong relationship with network externalities; this is characterized by the benefits that users can get from a network technology (Katz and Shapiro, 1985). A telephone or an email account is more useful when more users subscribe to the services. Note, however, that network externalities can also be applied to a market that does not have physical networks (Schilling, 2002). For example, the usefulness of a DVD player is strongly related to the availability of DVD titles. The incentive of DVD title suppliers increases when the number of adopters of the compatible DVD player grows. In other words, users of DVD players get more benefits with more adopters.

Compatibility is a very important factor when discussing network externalities. We cannot expect a single product to be dominated by a single company. Rather, it is quite natural for a single product to be provided by multiple companies. If multiple companies provide different configurations of the products (and this means that they are incompatible), the users of the product cannot enjoy the full utilities of the product systems because of the limited network externalities. Standardization can ensure the compatibility of the products, and this in turn provides more value to their adopters. Many complementary components are necessary to complete a product in an innovative industry wherein standardization is a very important issue. Compatibility or standardization enables more manufacturers to provide more interchangeable products.

Network externalities exist if there is a total effect and a marginal effect (Farrell and Klemperer, 2006). Total effect is that wherein one user's adoption of the product benefits its other adopters, whereas marginal effect is one wherein one user's adoption of the product increases the incentives for others to adopt the product.

The effects of network externalities can be classified into direct network effects and indirect network effects. When there are direct network effects, the benefits of the participants are directly affected by the size of the network. A good example of direct network effects can be found in the communication network particularly telephones and email accounts. Note, however, that network effects may work differently in market trading (Farrell and Klemperer, 2006). In fact, the network effects may be negative for the participants if the market is divided into distinct groups of adopters. Under the assumption of market externalities, all traders want to join (or adopt) a big market since bigger markets work better. As such, all the participating traders expect bigger gain when the market grows. When traders can be divided into two distinct characteristics such as buyers and sellers, however, it does not necessarily follow that each adopter joining one of those groups makes all others in that group better off or encourages them to adopt. Since the price of a good is determined by the equilibrium of demand and supply, buyers get more when more sellers join and lose more when more buyers join. This is because a buyer does not trade with another buyer and may suffer from the adverse network externalities. Therefore, network effects need to be analyzed after the network is characterized.

Indirect network effects usually come from the linkages between the core products and complementary products. Typically, indirect network effects can be seen in the linkages between hardware and software. The demand increase of hardware, i.e., growth of the hardware network, triggers an increase in various software supplies; the increased supply of software in turn indirectly increases the benefits of hardware users. With the emergence of digital convergence, the indirect network effects are drawing a lot of attention from the researchers as well as practitioners. For example, the transmission of digital contents of IPTV and VOD is carried out via streaming; the relationship between the streaming digital media systems and digital contents is analogous with that of hardware and software. The success of Apple's i-phone is partly attributable to the success of App. Store wherein the indirect network effects are explicit. Thus, we can easily understand that indirect network effects are salient in the industries of computers, broadcasting, and DVD players.

In terms of market structure, indirect network effects are analogous with the market equilibrium mechanism. When an additional buyer joins the buyer group, the seller group seems to gain a marginal effect, i.e., attracts additional sellers. Therefore, the total and marginal effects of the additional sellers in the buyer group may be due to the additional buyer, albeit indirectly. If those effects are greater than the negative effects of the joining of an additional buyer for the buyer group, the additional buyer wields indirect network effects on the buyer group; the seller group is considered a mere background mechanism (Farrell and Klemperer, 2006).

The network effects can be understood relatively simply in a single product market wherein price is an important factor when explaining the network effects. For instance, a mobile operator offers subscribers very low charges for the services to dispel the consumer's view that the services will be phased out if there are no sufficient subscribers. In that case, buyers faced with switching costs want to buy a product that a sufficient number of other buyers will also purchase (Beggs, 1989).

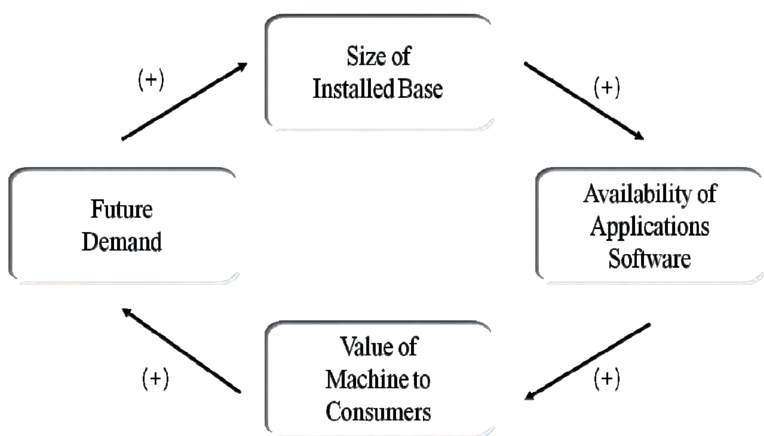
Note, however, that this concept gets an additional layer with the background mechanism to re-equilibrate the sellers of varied components to a platform adopted by buyers (Farrell and Klemperer, 2006). With IBM opening its PC architecture, more vendors supplied software that would run on IBM compatibles; thus making the IBM compatibles more valuable to adopters compared with Apple computers.

The same thing happens in a traditional product market such as automobiles. People want to purchase popular cars since there are many trained mechanics and abundant parts suppliers, in which case repairing them would incur less cost.

Since network externalities are determined by the installed base of the given product, a large installed base sometimes shows the self-reinforcement of increasing returns (Hill, 1997). A typical example is the battle on the GUI (Graphical User Interface) standard between Wintel standards – which are based on Microsoft's Windows and an Intel microprocessor -- and Apple's Macintosh operating system and a Motorola microprocessor. Since the installed base of Wintel was a lot larger than the Apple system, software developers provided application software for the bigger market even if Apple was the first to introduce GUI in the market. Given the more available software in the market, users placed more value on the Wintel system; this resulted in a larger installed base for the Wintel system, which in turn attracted more software developers for the Wintel system. As shown in Figure 8-1, these relationships have a self-reinforcing feature and show increasing returns to the participants.

In the market for some digital goods, however, the impacts of network externalities are neutralized in the presence of digital conversion technology. Liu, et al (2008) have empirically investigated the interaction between conversion technologies and technology adoption in the flash memory card market characterized by standards competition. The research found that the presence of digital converters moderates standards competition by offsetting some of the network effects. This finding suggests the need to take a careful approach in understanding the network externalities under the digital environment.

Fig. 8-1 ▶ Increasing Returns in the Personal Computer Industry (source: Hill, 1996)



8.1.2 Interface Standards and Market Expansion

With product markets becoming increasingly complex due to the introduction of digital technologies, the interoperability of complementary devices is a crucial factor in market expansion especially in information industries. Interoperability between different product markets can be maintained through the adoption of interface standards.

The success of the PC industry is mainly attributable to the introduction of interface standards between components. In the old computer industry, the computer system was vertically integrated so that the basic hardware such as the basic circuitry and computing platform was integrated with the operating software, and software applications were unique to a specific hardware. Under these circumstances, a very small number of vendors were available in the pricey IBM-led market. This kind of market structure was the main constraint of market growth. With the advent of PC, however, the computer system became modularized. This means that the computer industry has been horizontally segmented with multiple suppliers in each layer of the system. In the microprocessor layer are multiple suppliers such as Intel and Motorola; in the platform layer are other clone suppliers such as Compaq aside from IBM. The computer system is completed with the assembly of the necessary modules in each layer. This was made possible by the introduction of interface standards, which allowed each module to be assembled and to communicate with each other.

Interface standards can connect different markets. If one side of the market is small compared with the other side of the market, we can expect the small market to grow with the help of the other side of the market by adopting interface standards. In other words, interface standards may affect the new product market such that the market size grows to that of the adjacent product market. For instance, digital cameras and printers were considered peripherals of computer systems. The growths of these two markets are strongly tied up with the growth of the computer market, so they were forced to employ cost competition along with that of the computer market. Note, however, that the invention of interface standards between the digital camera and the printer made their markets independent from the computer market. As a result, these two markets have grown rapidly.

With interface standards, consumers can enjoy mix and match components from different manufacturers to get the best performance vis-à-vis prices. Competition on the product is not for the whole system but for the component bases. Mackie-Mason and Netz (2006) have discussed the benefits and costs of component competition. The benefits are summarized below.

Competition on price and performance: If interface standards are published, more new entrants join the market for the individual components; this may result in increased competition on price, performance, and quality of the components.

Scale efficiencies and lower production costs: As we can see in the case wherein Apple Macintosh hardware typically costs more than comparably performing IBM PC clone hardware, public interface standards may increase the size of the relevant market and enable the participating firms to realize efficient scale and lower production costs.

Network externalities: Since interface standards may have the effect of increasing the market size, more users will have to join the market. In this case, consumers benefit more when there are a greater number of other users of the same product.

More innovation and variety for components: If the interface between complementary components is standardized, a firm making one component in a system has an extended market. When the potential payoffs are larger, small, innovative firms will find taking a risk -- to introduce an innovative component in the market -- worth their while.

Reduced risk of stranded investments: If interfaces are standardized, consumers will have assurance that the components they purchase will work with other components as well as a base system.

The costs of component competition are summarized below.

Reduction in system design variety: System competition, not component competition, will bring about more system designs in the market. When interfaces are proprietary, an innovative design in one component may introduce a whole new system in the market.

Network externalities: If there are many users of the existing standardized system, there would be less incentive to innovate and to develop a better system. This is because consumers may find switching from the existing system to a new one -- without knowing for sure that a sufficient number of other users will switch, too -- too costly.

Even with the costs of component competition, the general benefits of adopting interface standards can be easily understood if one can imagine what will happen when computer manufacturers do not use interface standards for attaching peripherals or when software designers do not adopt a common user interface. Clearly, interface standards wield great impact on market expansion.

8.1.3 Standardization, Cost Reduction, and Differentiation

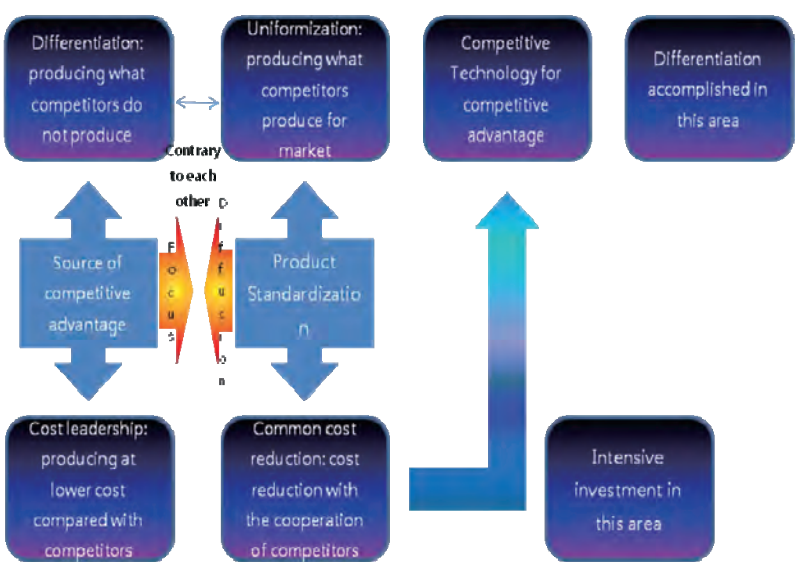
The effects of standardization could be discussed vis-à-vis two main themes: market expansion and cost reduction. As discussed above, standardization affects market expansion. In the case of cost reduction, firms usually reduce the operating cost by employing standardized components and manufacturing processes. This is usually accomplished by developing in-house standards. Another source of cost reduction is consensus standard in the market. With more firms recognizing the importance of standards, it is going to be more difficult for a single firm to monopolize the standard setting. No firm will have zero competitors in establishing de-facto standards, and they have learned from experience that they will incur immense costs if they lose the battle. In today's business environment characterized by technology convergence and complexity of the product, it is almost impossible for a single company to cover all the necessary technologies for the product. Therefore, consensus standards will prevail in the market.

The consensus standard may increase the number of market participants. The benefits derived from the greater number of market participants usually go to the consumers instead of firms. If firms purchase their raw materials from the market with more participants, however, those firms are also beneficiaries of the consensus standard. In particular, firms can purchase standardized raw materials at less cost since the introduction of the consensus standard for the raw material may trigger competition among the suppliers.

In his famous book "Competitive Advantage," Porter (1985) stresses that there are two basic types of competitive advantage that a firm can have: low cost and differentiation. Cost leadership is supposed for a firm to become the low-cost producer in the industry. Standardization can realize cost reduction in many ways. For a firm employing in-house standards, this will help the firm pursue cost leadership in the industry. If the standards are the consensus standards, however, cost reduction is not restricted to a single firm pursuing cost leadership in the market; every firm employing the consensus standards may achieve the same level of cost reduction, thereby securing for a firm achieving the biggest cost reduction the cost leadership in the industry. Of course, there may be some discrepancies among the competing firms with regard to the production costs due to the differences in their operating efficiencies.

Differentiation through standardization is another story. Standardization and differentiation hardly go hand in hand. If a consensus standard has been developed in a certain area of the product system, it means that the standardized area is open to anybody with or without paying the license fee. With the open area, a firm cannot realize differentiation because all the specifications for that area are common to every participant. To pursue product differentiation as a firm's competitive strategy, reducing the standardized area of the product system is recommendable. With the reduced standardized area, however, accomplishing market expansion is difficult since not many participants join the market. To achieve market expansion, a large area of the product system needs to be standardized at the expense of differentiation. Therefore, differentiation and standardization are likely to have a trade-off relationship. A firm's strategic consideration is subsequently required to decide where to standardize and how to differentiate.

The relationship between standardization and competitiveness is shown in Figure 8-2, wherein firms are found to invest their resource savings from employing standards in the development of competitive technology for differentiation. Cost leadership is one of the competitive strategies that should be pursued by a single

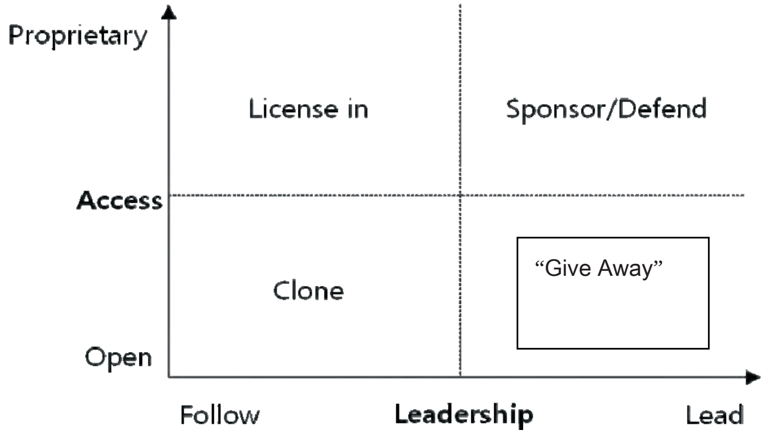


◀Fig. 8-2 Relationship between product standardization and competitiveness (source: Shintaku and Eto, 2008) firm in the industry. In a business environment wherein no single firm covers all the necessary technologies for the complex product, however, we will see more of multiple firms striving together to develop and standardize the technologies to reduce the cost of production (Shintaku and Eto, 2008).

8.2 Characteristics of Strategic Positions vis-à-vis Standardization

The capability of a firm with regard to standardization influences its market positioning strategy. Specifically, a firm's capability as to how to develop or utilize standards determines the level of market dominance or market entry. The position is dependent on a firm's standardization leadership -- which in turn determines whether to develop a proprietary standard or to adopt that of others -- and on a firm's access to a standard, which is either proprietary or open (Grindley, 1995). Figure 8-3 shows the 2X2 matrix with the 4 basic options explaining the concept above.

Fig. 8-3 ▶ Strategic Positioning Decisions (source: restructured from Grindley, 1995)



While "Sponsor/Defend" means that a leader firm develops a proprietary standard and places restrictions on the use of such standard by competitors, e.g., charging license fees, "Give Away" means that a leader firm encourages other firms to adopt the open standard it developed without restrictions. "License in" refers to a situation wherein a firm adopts a proprietary standard established by another firm. In "Clone," a firm adopts an open standard without restriction.

A positioning decision needs to be made together with an examination on the standardization trends of the technologies in question at the R&D stage. This is because the standardization strategy should be aligned with the business strategy wherein R&D planning is the first step to incorporate standardization and production. More specific features of the basic options are discussed by Grindley (1995) as follows:

8.2.1 Sponsor/Defend: Having Leadership with Proprietary Standards

This position is available for a firm with the ability to establish standards and to lead the market. The advantage of this position is that the firm maintains strong control over its sub-market as well as large share and high margin provided the protection from imitation is strong enough. The firm needs to keep its market share growing and its technology competitive so that it can defend its market from potential entrants. The firm earns some profits by licensing the technology to other firms instead of doing all the manufacturing itself. This is also necessary to diversify the risk of investment if the market is at its infancy stage. In the case of Philips's efforts to establish DCC (Digital Compact Cassette) as an industry standard, Philips competed against Sony's minidisc systems without the help of other alliances. Faced with two competing and incompatible systems, consumers were reluctant to decide purchasing either of them since nobody knew for sure which system would win over another system. The best strategy of the consumer under these circumstances was wait-and-see, which would help neither system (Hill, 1997).

A barrier to imitation is one that prohibits competitors from replicating a firm's technology. A high barrier decreases the incentives for the firm to make licensing agreements assuming the firm has built an installed base. Note, however, that building the installed base is very difficult if the firm is the sole supplier of a standard-defining technology. By pursuing this strategy, the firm has to provide the core product as well as all the key complementary products by itself. The firm can take all the profits in the market if this approach is successful. A success story of this approach is the Intel X86 series microprocessors as a standard in the PC industry with the help of a sophisticated standardization strategy (Hill, 1997).

The drawback of this approach is that the absence of broad support of many manufacturers and co-producers may either prevent the standard from taking root in the market or cause it to be limited to a niche market. One of the reasons Sony Betamax has failed in the market is the lack of mass production capabilities of the licensee firms. Since Sony had always been uniquely innovative with consumer products incorporating advanced electronics, Sony managers were unwilling to compromise on their standard or help potential licensees with OEM shipments (Cusumano, et al, 1991).

Another example showing the danger of this approach is the experience of Xerox in Japan (Hill, 1997). When it launched its business in Japan, Xerox had enough resources to establish its technology as a standard; its technology was also protected by a high imitation barrier. With Xerox dominating the generic market including the high-end one, the lower end of the market was left as a niche market exploited by Canon, Ricoh, and Konica, which developed their own technologies without infringing Xerox's patents. After a successful business in the niche market, Canon, Ricoh, and Konica wrested the leadership from Xerox. Later, Kodak Ektaprinter captured the leadership in the high-end photocopying machine market. A large sample study of patent protection revealed that 60 percent of the patented innovations were invented within approximately four years (Mansfield, et al, 1981).

8.2.2 "Give Away": Having Leadership with Open Standards

This position is appropriate when a firm with the technical capability to lead standardization wants to have more supporters for its technology owing to the fierce market competition on the technology or product related to the standard. With an open standard strategy, a leading firm may establish a large market wherein the development of standards is facilitated by the wider support from other manufacturers and co-producers. Furthermore, the standard development and market establishment cost/risk can be shared among the participants. On top of these benefits, one can expect the network externalities to be created since an open standard strategy may attract many users to build an installed base. Licensing a firm's technology to other firms may facilitate the creation of an installed base. A typical example of adopting this strategy to ensure success in the market was when Matsushita licensed the VHS technology to other consumer electronics firms including Hitachi, Sharp, Mitsubishi, and Philips (Hill, 1997). As another benefit of this approach, the increasing number of manufacturers adopting the open standard sends a positive signal to the market participants especially to the complementary suppliers. The supply of complementary products is one of the critical factors impacting the success of core products in many cases. Suppliers of complementary products may invest in the development of the product once they recognize the installed base of the core products. In turn, an increase in the supply of complementary products may increase the utility of core products and satisfaction of consumers. This mechanism shows the increasing returns to the participants of the open standard (Hill, 1997).

As a disadvantage of this position for a leading firm, however, as the market is divided with many participating manufacturers, the market share of the firm may be small even though the market size expands. Since there may be a large number of competitors in the market, the market competition could be very stiff, in which case the leading firm may have trouble securing the appropriate level of profit. The IBM PC is a typical example of this approach. With an open standard strategy, the IBM PC had expanded the market size but could not maintain the appropriate level of market share because of the fierce competition with clones such as Compaq. In the case of VHS technology, Matsushita had to compete against those licensees in the final market. Another risk of this approach is that the adopters or licensees of a technology may alter the technology into an even better one than the original technology. Furthermore, licensees do not pay royalties to the licensor. AMD was sued by Intel for royalties for the sales of the K5 microprocessor, which was AMD's clone of Intel's Pentium microprocessor. According to the claim of Intel, K5 originated with the Intel technology licensed to AMD to produce the 80286 processor. Nonetheless, AMD asserted that K5 utilized a microcode developed in-house, and that it was consequently not covered by any prior license agreement (Hill, 1997).

8.2.3 License in: Adopting a Proprietary Standard due to the Lack of Standardization Capacity

A firm without an appropriate capability to develop a standard but entering a market with a dominating standard is left with no choice but to employ an existing standard. Even if a firm has high technical capability, it will have considerable difficulty in competing against a market-dominating standard. Under these circumstances, it is unreasonable for the firm to invest its resources in developing another standard.

Adopting a proprietary standard is usually the least attractive approach especially if the firm is a late entrant in the market. Since there may be privileged supporters of the proprietary standard, it would be very difficult for the firm to take the place of the privileged firm. Usually, the firm has little control over product strategy, and it may pursue cost competition in the market. Cost competition usually drives a firm into a harsh condition that should have been avoided in the first place. Moreover, the firm may have to pay license fees or withdraw from the market. The advantage of this approach is that the standard is already proven in the market. Thus, the firm with excellent manufacturing competency and/or marketing capability can survive in the market. A competitive strategy of the firm would be one that accomplishes differentiation for the product interfacing with the standardized area. This is the general approach of a firm entering a market wherein standardization has been completed.

8.2.4 Clone: Adopting an Open Standard due to the Lack of Standardization Capacity or Absence of Intention to Participate in Standardization

A firm adopting an open standard does not necessarily always have low capacity for standardization. A firm may secure a stable revenue source by adopting an open standard, in which case a firm may join allies and contribute to expanding the market. The adopter of an open standard is on equal footing with competitors and not in a fringe position when the market is characterized by high competition and provision of lower margin. Many success stories of firms in newly industrialized economies are attributable to the adoption of this strategy since such firms have competitive advantage in terms of cost structure and efficiency of operation. With the accumulation of know-how and capital, those firms can join the standardization process depending on their business strategies in the future.

The discussions above regarding the 4 quadrants show the characteristics of the position that a firm may take with regard to standardization. The following are the specific standardization strategies of firms based on their technological leadership in standardization. Firms may consider the following strategies while acknowledging the features of the 4 quadrants:

8.3 Leader Strategy

One of the things that the standardization leader has to consider is the diffusion strategy of standards. The level of diffusion is mainly affected by the degree of openness of the entire system including the standards (Shintaku and Eto, 2008). The openness of the system is decided by the areas of standards as well as how IPR and royalty are invoked. The decision as to which area of the system is open through standards and which area is left as a black box is related to the business strategy of a firm pursuing competitive advantage. Competitive advantage for a firm cannot be obtained in every aspect of the business. A firm has to decide how to create a market and how to compete in the market with a proper business model, especially if the firm is a technology leader of the industry. This is why decisions on the areas of standardization as well as how to build a business model and how to control the standardized area are strategically important for the leader firm to sustain the competitive advantage once the standards are established.

8.3.1 Strategic Importance of the Areas of Standardization

As mentioned above, the diffusion strategy of standards is related to the areas of standardization. A leader firm wishing to secure a high profit margin may narrow the standardized area and ask for a high license fee. Note, however, that this may hinder the diffusion of standards and growth of the market. If a leader firm decides to have a large area of standardization, such may attract many manufacturers to join the market so that more users can purchase the products with less fear of lock-in, and the rapid growth of the market may be triggered. Still, this will pose some disadvantages to the leader firm. With more manufacturers joining the market, the competition in the market is going to be very fierce. Moreover, since differentiating in the standardized area is very difficult, the leader firm does not maintain a competitive edge in the market with a large area of standardization. A firm that cannot employ a differentiation strategy has to pursue a cost leadership strategy wherein firms in newly industrialized economies have competitive advantage. This is why the decisions on the areas of standardization are strategic ones that a leader firm has to make. The standardization of Japanese bicycles shows the importance of areas of standardization in maintaining a competitive edge.

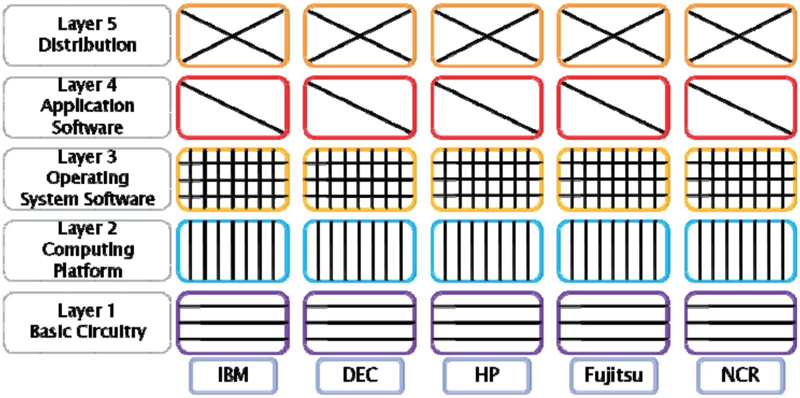
Case: Japanese Bicycle Industry

In 1954, the Japanese government established the Japanese Industrial Standards for bicycles to improve the quality of the domestic bicycle so that domestic manufacturers could compete against European manufacturers in their export market. During the standardization process, standards for almost every single component of the bicycle were established to improve the quality of the product. Since the introduction of the standards for the bicycle, the competitiveness of Japanese bicycle manufacturers -- which were mostly SMEs – had improved considerably because any manufacturer could produce almost the same quality for the bicycle if it followed the standards that were specifically provided. Observing this to be very successful, the Japanese government kept improving the standards. Note, however, that the beneficiaries of this approach were not restricted to the Japanese manufacturers. Since the JIS was open to everybody in the world, and the standards for the bicycle covered every detail of the components, Chinese and Chine Taipei's manufacturers employed the same standards for their productions. After the abolition of the tariffs on the bicycle in 1990, the Japanese bicycle market was invaded by Chinese and Chine Taipei's manufacturers. By 1998, China was the biggest bicycle exporting economy, with the imported amount surpassing domestic production in 2000. Today, Japanese finished bicycle manufacturers are almost suffocated by imports from developing economies (Shintaku and Eto, 2008).

As shown in the case above, having wide areas open apparently sometimes brings about unexpected competitors in many ways. Some may come from the adjacent industry, and others, from another economy. The opening of the IBM PC architecture attracted a lot of participants from various industries, and MS was one of them. IBM had taken advantage of the market externalities created by the wide opening of its architecture at the initial stage. Since IBM did not respond properly to the changes in competitive mode triggered by the business environment change including the introduction of standards in the industry, however, MS took the place of IBM. Since then, MS has maintained leadership over related industries.

8.3.2 Business Model and Standardization

The structure of the computer industry was changed from a vertically integrated vendor structure to one with multiple horizontal market segments. As shown in Figure 8-4, the old industry was dominated by a small number of vendors providing

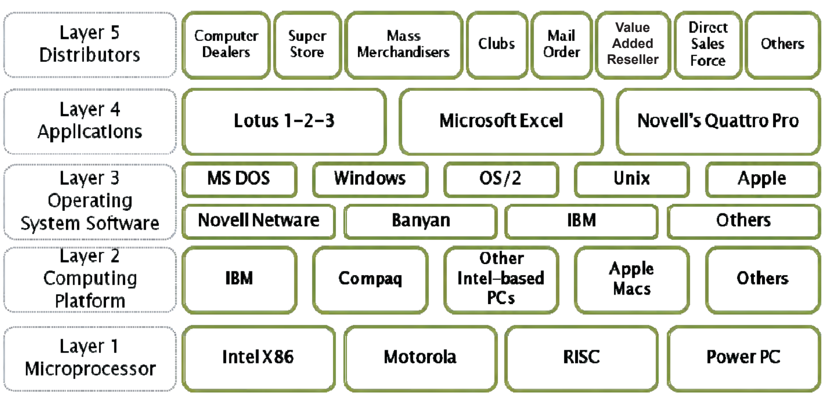


◄Fig. 8-4
The Old Computer Industry
(source: Callon, 1996)

proprietary systems. Under this environment, computer acquisition was primarily a vendor decision. When deciding to purchase the necessary application software, a company had to consider not only the application itself but also the basic hardware since the application software was probably unique to the hardware proposed by such vendor (Callon, 1996).

The new PC industry structure shown in Figure 8-5 was the result of the introduction of interface standards between each layer wherein thousands of firms compete. Since the biggest revenue has been coming from PCs since 1993, viewing the industry from the perspective of PC segment is only appropriate. When purchasing a PC, a consumer can make his/her choice depending on his/her needs. Without the interoperability of the components of the system, this kind of structure -- wherein interoperability is ensured by the adoption of interface standards -- cannot be realized. Under these circumstances, competition intensifies in each layer, and firms focus on doing what they can do best. As a result, MS's share today is a small fraction of that captured by IBM in the mid-1960s, yet the influence of MS on the industry is greater than that of IBM at that time. MS has provided increasingly powerful operating systems that effectively enhance the functionality of basic PCs; thus securing for MS the leadership of the industries. As we can see in the computer industry, standardization sometimes triggers a different competition mode that may bring about changes in competitive advantage and enable the emergence of a new face to dominate the markets. Thus, it is very important for a firm to have its own business model when deciding what to standardize.

Fig. 8-5 ▶ The New Computer Industry (source: Callon, 1996)



Case: Intel's Business Model with Standardization

A motherboard is the central printed circuit board including the CPU in a personal computer. Computer vendors produced the motherboard to upload the CPU for their own. Vendors used to enjoy state-of-the-art computer systems using the latest motherboard for 18 ~ 24 months by imposing premium prices. These vendors could get enough returns on the R&D for the motherboard during that period with a small supply of the high-end PC. Note, however, that Intel was not satisfied with the 18 ~ 24 months' cycle since it could supply only a small amount of CPUs to the market during that cycle. Making a 360-degree turn, Intel announced a new ATX (Advanced Technology Extended) motherboard standard that was strongly supported by Chine Taipei's manufacturers. Before the introduction of the ATX standard, a typical motherboard standard was the AT standard employed by IBM/PC AT. The AT standard was IBM's in-house standard, which was not specific enough; thus foregoing the need for clone manufacturers to customize the motherboard when assembling the entire system. Because of this problem, clone manufacturers had to discuss with motherboard manufacturers regarding the specification of the motherboard. While North American motherboard manufacturers produced high-end products, their Chine Taipei's counterparts supplied low-end products based on volume production for a low price at that time. It was reasonable for the vendors -- which were mostly located in North America -- to have their high-end motherboard suppliers nearby since they had to communicate very closely with their suppliers. With the standardization of the motherboard as pursued by Intel, however, the need for communication between the vendors and the motherboard suppliers decreased, and motherboard manufacturers in Chinese Taipei were given a strong incentive to move from a low value-added product segment to a high value-added product segment by supplying state-of-the-art motherboards. As a result, the production volume of Chine Taipei's motherboard manufacturers increased very rapidly to more than 90% of the world market. The ATX standard became prevalent for 5 years after its introduction (Shintaku and Eto, 2008).

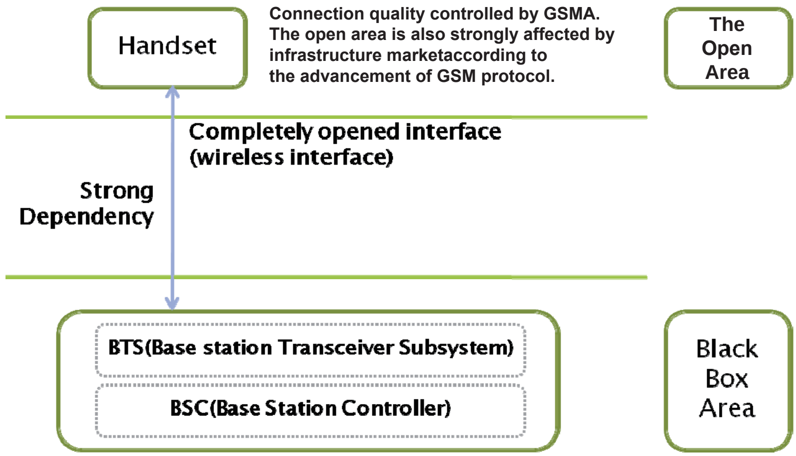
The standardization strategy pursued by Intel shows the importance of areas of standardization and the business model to be competitive in the market. What Intel pursued was not the standardization of every component of the PC system, but the standardization of key components to have the PC price go down so that more consumers could purchase PCs. With the provision of the motherboard standard to the market, the price of the high-end motherboard dropped drastically with the help of manufacturing firms in developing economies, and more consumers were able to purchase more high-end PCs at a reduced price. Intel also participated in standardization processes other than that for the motherboard. Note, however, that the main business of Intel was not directly related to motherboard manufacturing. As we all know, the main business of Intel was developing and providing the CPU and chip set -- which were kept as a black box -- so that they could enjoy competitive advantage in the industry. Intel tried to standardize interfaces with peripherals so that they could be connected with the Intel platform whose inside was kept as a black box. Even though the price of the computer system has dropped very rapidly due to the changes in competition mode as shown in the figure above including the price of peripherals due to the fierce competition triggered by interface standards, Intel has maintained high growth and profit margin since the 1990s. The success of Intel is partly attributable to the adoption of a strategic standardization process as well as the accompanying business model.

Standardization alone does not guarantee market expansion. In the network product market in particular, coordination with complementary product manufacturers is required to complete the strategic standardization. Even if the characteristics of coordination are different, what made Sony and Philips keep CBS Records and PolyGram, respectively, as their subsidiaries for the supply of the CD program, what made the Toshiba group forge an alliance with Hollywood film makers to secure a favorable position in the standardization competition, and what made Linux open the source code to cooperate with more software suppliers were the same: to achieve market expansion through coordination with complementary products. Another recent example can be found in the cable TV industry wherein network operators, system operators, and program providers are complementary to each other. As the business environment changes, such as the proliferation of global competition, deregulations, and technology convergence, the scope of coordination extends from hardware-software, and network contents, to the overall value chain of the entire industry. Moreover, the competition is between groups of firms, with a group consisting of firms complementary to each other.

8.3.3 Control over a Standardized Area

As we can see in the Intel case, the standardized area was left for the new participants from a newly industrialized economy, i.e., Chinese Taipei, with Intel enjoying the sales growth of CPU due to market expansion triggered by standardization. An open area through standardization usually attracts a lot of new participants since the level of competition increases. With increased competition, however, the profit margin of the industry is eroded. Manufacturers from newly industrialized economies can participate in the standardized area since they can have a relatively low cost structure compared with those from industrialized economies. Therefore, a major concern of technology leader firms should be how best to proceed once they have won a standard war. Those firms may have some privileges to enjoy what they have achieved. In today's business environment, however, the battle never really ends. To sustain the competitive advantage that firms have through technological leadership, they need to be a moving target for those following them. There are many ways of executing the strategy.

The GSM (Global System for Mobile communications) handset case is a highly relevant example, being a high-tech industry wherein standards play an important role and standardization leader firms still maintain a high market share even though the handset standards are very specifically established. GSM may be a typical case wherein a serious conflict between IPRs and standardization occurred. As of 1996, five players (Ericsson, Nokia, Siemens, Motorola, and Alcatel) dominated the market wherein they held around 85% of the market or more in each of the three segments: switching, base stations, and terminals. There were too many IPRs needed to complete GSM and too many holders with different vested interests. Motorola had a distinct position from the other European firms with regard to the IPRs; it patented a lot of GSM technologies while standards were being developed. In contrast, the other European participants did not protect their technologies embedded in the standards. After long talks among the major participants in the development of GSM standards, they reached a conclusion: to have cross-licensing agreements (i.e., Ericsson, Nokia, Siemens, Motorola, and Alcatel) so that they could dominate the market for GSM infrastructure and terminals (Bekkers, et al, 2002). The GSM architecture is presented in Figure 8-6.



◀Fig. 8-6 GSM Mobile Communication System (source: Shintaku and Eto, 2008)

The handset market and infrastructure market are connected with the standardized interface system. As discussed earlier, new participants from newly industrialized economies may emerge as important players in the GSM handset market, which is open through standardization. Note, however, that standardization leader firms still maintain competitive advantage in the market since the infrastructure market affects the handset market. The two different markets seem to behave independently because of the open interface between the two markets. Nevertheless, as a GSM protocol, i.e., an interface standard advances continuously, players in those markets need each other to confirm the connectivity of infrastructure and handset; thus making both markets depend on each other. Moreover, standardization leader firms in GSM enjoy dominating leadership in the infrastructure market due to the strategy of keeping the BTS and BSC areas as a black box. To maintain quality connectivity, handset suppliers are required to get a certificate for connectivity issued by GSMA (GSM Association) when operators procure handsets. Since operators do not employ any handset without the certificate of connectivity issued by GSMA, the dependence between infrastructure and handset is maintained to assure connectivity. Due to the standardization of the GSM mobile system, however, non-European operators such as Asian operators can employ the GSM system even without accumulated technical know-how. Meanwhile, standardization leader firms keep the infrastructure area as a black box, in which case they control the standardized area by upgrading the black box area. Intel is another example of successfully controlling standardized areas by providing CPUs maintained as a black box (Shintaku and Eto, 2008). As we can see in this example, a technology leader needs to be a moving target instead of staying on the same position.

The Minitel system in France is a typical example of failing to respond properly to technical changes and staying on the same position. Before August 1997, the French government – which was maintaining Minitel -- refused to acknowledge that the Internet would be the way of future communications. One of the reasons for the French's sluggishness in moving to the Internet was the reluctance of French Telecom to move to the Internet base owing to the switching costs involved. The lesson to be learned from this case is that if a firm cannot improve its technology over time, it will be overtaken sooner or later, and will be forced to cede its position to the competitor (Shapiro and Varian, 1999). Another tactic suggested by Shapiro and Varian (1999) is "If you have a good development team, you can build a bandwagon using an 'openness' approach of ceding current control over the technology (e.g., through licenses at low nominal royalties) while keeping a tight rein on improvement and extensions. If you know better than others as to how the technology is likely to evolve, you can use such informational advantage to preserve important future rights without losing the support of your allies." IBM was the one that could not control the standardized area; it failed in the market since it did not pay attention to the demand of consumers but adhered to its traditional strategy instead to maintain the market.

8.4 Follower Strategy

Standardization is usually accomplished on a part of the system. A standardized subsystem becomes an open area, allowing new entrants to join the market. Because of the new entrants, market competition on that subsystem intensifies; the value-added mechanism may be changed as well. With the introduction of the standardized subsystem, most of the value-added on that subsystem is used to move to other subsystems wherein differentiation could play a major role. As more players join the market, the profit margin of the subsystem market is reduced, and more value moves to other subsystems. Therefore, there is a need for the other subsystems to rebuild their architecture to capture the value-added moving from the standardized subsystem. The movement of value-added usually occurs on either the upper layer or lower layer of the standardized subsystem. The upper layer refers to a logical layer that makes the differences in the standards employed in the product hazy for product users by integrating different product functions. The lower layer is the layer of components making up a finished product. Followers of standardization would do well to position themselves on the upper layer or lower layer depending on the market environment considering their technical capability.

8.4.1 Placing on the Upper Layer

If innovation is being made actively in the standardized layer, firms placed on the upper layer may capture the value-added that moved from the standardized layer. In the case of the DVD standardization process, DVD-R, DVD+R, and DVD+RAM were competing standards at the initial stage; they were not compatible with each other. For instance, DVD-RAM could read data recorded in DVD-ROM, but not the other way around. With Pioneer establishing another standard DVD-R that could be read in DVD-ROM, the DVD-R market grew very rapidly. As a result, the DVD forum established in 1997 employed the DVD-RAM standard and DVD-R standard as formal standards. As discussed in the introductory case, under the DVD-ROM's circumstances of emerging innovative technologies, consumers were very reluctant to purchase any of the new devices until the market decided on a de facto standard. Super multi-drive (SMD) led the market wherein it could correspond to all the competing standards. SMD was positioned between the end-users and the standardized layer wherein Matsushita and Hitachi were the major players. Technological capability is an important factor in developing a product that satisfies multiple standards (Shintaku and Eto, 2008). For capable firms, the strategic placing of their technologies is another factor to be exploited under the turbulent business environment.

8.4.2 Placing on the Lower Layer

If innovations have already been made in a standardized layer, most of the value-added of the system may move to the lower layer. During the innovations, the needs of consumers are considered in the design and functions of the system. Since all the necessary functions of consumers have been explicitly fixed, the components of the system implementing those functions are also fixed. Components are divided into core components and auxiliary components. More value is added to the core components since most of the new participants from newly industrialized economies may not have the capability to produce the core components; they have to purchase the core components to produce the final system. This is why most of the value moves to the core components. Even though most of the value-added moves to the lower layer, the architecture of the lower layer will most likely be modified to prevent the components of the lower layer from becoming standardized (Shintaku and Eto, 2008).

As discussed above, the bicycle industry is a typically standardized one wherein innovations have been fully made. Founded in Osaka, Japan in 1921, Shimano is a bicycle component supplier specializing in gear box and freewheel. Shimano developed its own components without following the standards. It keeps its technology as a black box using patents. Note, however, that it standardized the interfaces so that its components could interoperate with the finished bicycles. Since their components can interoperate with almost all kinds of bicycles using interface standards, manufacturers of finished bicycles procure Shimano's components to enhance the performance of their finished products.

Questions and Discussions

1) How does standardization affect the network externalities?
2) Explain how standardization affects market expansion and differentiation.
3) Discuss the strategic position of a standardization follower firm vis-à-vis the emerging technological innovations in the standardized area.

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Chapter 09

Collaborative Strategy

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Learning Objectives

After completing this chapter, you should be able to:

a) Implement the collaboration strategies of companies to earn the status of dominant design.
b) Explain the advantages of collaboration for technological standards.
c) Describe the recent trend of cross-licensing to avoid the infringement of intellectual properties.
d) Evaluate the benefits of cross-licensing and strategic alliance.
e) Discuss the definition and objectives of consortium.
f) Learn the principles of choosing the right partners in creating an alliance.

Opening Case: Liberty Alliance Project

Since the Internet is widely used, various categories of personal information are stored in a website. Such information ranges from simple demographics such as name, phone number, social security number, and address to complicated behaviors such as credit, loan, fashion style, and favorite news. Such identification information as stored and managed across different server computers on the Internet is called network ID.

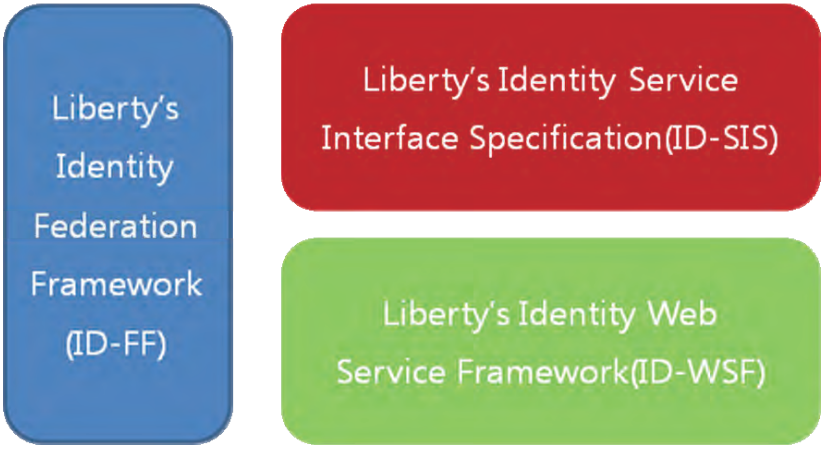
Network ID is stored in many different websites such as portal site, mail server, and online shopping mall. Therefore, Internet users have to undergo the inconvenience of entering the same ID information repeatedly for registration or authentication; they are also vulnerable to the risk of malicious trading of personal information and invasion of privacy. Thus, the liberty alliance project is in progress to address such risks.

The Liberty Alliance Project is an alliance launched in October 2001 with the participation of 33 global companies such as American Express, AOL Time Warner, Bell Canada, Citi Group, France Telecomm, General Motors, Hewlett Packard, Master Card, Nokia, NTT Docomo, Open Wave System, RSA Security, Sony, Sun Microsystems, United Airlines, and Vodafone. This alliance is actually in competition against the solely Microsoft-initiated web service dubbed Dot Net project.

The Liberty Alliance sets the following principles: 1) helping companies and customers maintain personal information safely; 2) providing the universal and open standard for single sign-on for the sake of compatibility for both users and service providers, and; 3) offering the open standard for network identity to be applied to every device connected to the Internet. To date, more than 3,500 companies registered for this alliance including SKT of Korea (Juktoma.com, 2004).

The architecture of Liberty's standards consists of three major modules (see Figure 1).

Fig. 9-1 ▶ Three Modules of Liberty Standards (source: IT Standard Weekly, 2004)



ID-FF (Liberty's Identity Federation Framework) organizes a federation connecting the ID information of users stored in various websites and offers website accessibility once a user authenticates on a website in the alliance. ID-WSF (Liberty's Identity Web Service Framework) provides the framework for the creation, retrieval, and use of ID services. ID-SIS (Liberty's Identity Services Interface Specifications) implements standard ID services on the basis of the ID-WSF framework. Liberty applies and extends the appropriate industry standards instead of developing and creating new manifestations of technologies. All the modules of Liberty standards are manifested to be compatible with OASIS, W3C, and IETF standards. Such compatible technical platforms include SAML, WS-Security, HTTP, WSDL, XML, SOAP, XML-ENC, XML-SIG, SSL/TLS, and WAP.

A total of 20 companies including AOL, Ericsson, HP, Nokia, and Sun Microsystems have passed the compatibility test of Liberty standards. The Liberty alliance emerges as an important movement, what with security and privacy issues surfacing as critical concerns in the Internet era. This alliance can produce a technological standard to balance the privacy protection and usability of websites, facilitating the setup of national standards for network ID management (IITA, 2004).

9.1 Overview

In today's global market, new products and business opportunities have emerged due to the rapid development of technology and innovative convergence. Globalization promotes limitless competition wherein only the best product and service can survive in the global market. Competition among economies and companies is getting fierce.

For the sake of survival in the limitless competition in the global market, companies need to participate in international standardization. Active participation in international standardization is accompanied by the agile development of new technologies, fast launch of new products, and taking of initiative in market leadership -- all of these are combined to generate sustainable revenues and realize cost saving. Such initiatives and active participation have given rise to numerous collaborations and alliances with foreign companies based on the recognition of the importance of international standards. In particular, such initiatives have been dominated by European and American companies.

The effective management of a collaborative network is a critical success factor for the successful completion of global standardization. One of the good examples is the HDTV standard in the US. Companies in the US organized an alliance to establish a standard quickly. The Fundamentals of Television in the US developed a new technology to cope with the digital age. HDTV is a new TV broadcasting technology that could match the evolution of cable and satellite technologies. The company pushed for the standards for the audio system, video coding, and transmission system; thus securing the first-mover advantage in a very short period of time (Carlo, et al, 1995).

As shown in the opening case, Liberty Alliance is a good example of developing an Internet-based open standard based on cooperation and collaboration among more than 150 organizations. The Liberty Alliance was formed in September 2001 by approximately 30 organizations to establish open standards, guidelines, and best practices for identity management. The vision of Liberty Alliance is to create an open standards-based, networked world wherein consumers, citizens, businesses, and governments can carry out online transactions more easily while protecting the privacy and security of identity information.

We can see many examples wherein companies implement a collaborative strategy to launch technological standards. This chapter discusses why companies organize a collaborative network for the sake of technological standards. The effective methods and critical success factors in organizing and managing a collaborative strategy are also reviewed. Among the various types of collaborative strategies, this chapter pays special attention to strategic alliance, licensing, and consortium with discussions on the advantages and disadvantages of each type of collaboration.

9.2 Benefits and Effects of a Collaborative Strategy

Collaborative strategy is the flexible and efficient way of acquiring the resources and skills of other companies. Therefore, cooperation is an indispensable, vital instrument to gain the advantage in the competition for technological standards. To date, the top 500 companies in the global business reportedly maintain about 60 strategic alliances on the average (Dyer, 2001). Successful cooperation helps raise the stock price and enhance market values in the competitive market.

Cooperation has numerous advantages. Note, however, that companies find deciding whether to join the standard-setting network quite a challenge in a competitive environment because no one can tell for sure whether the network can successfully end up producing a standard, how effectively such efforts contribute to setting a standard, and how profitable such cooperation can be to the participant companies as a consequence.

The most well-known advantage of cooperation is increasing the economy of externality because the probability of a technology becoming a standard increases as the aggregate size of firms offering a compatible product increases (Robert, et al, 1995).

Some companies create an alliance even with close competitors to create a synergy effect and develop a technological standard by increasing the overall size of force. A good example of alliance with competitors is the *OSF (Open Software Foundation) alliance*. Many software companies joined this alliance to offset the influences of Sun Microsystems and AT&T. Meanwhile, other groups of companies joined another alliance -- *Unix International* -- to hold the OSF Alliance in check. Such mutual surveillance enabled Unix and OSF Alliance to grow to similar sizes.

The emergence of such alliances in the computer industry has driven and motivated the fast standard-setting practices of Unix applications. This example effectively demonstrates that size is based on the expectations of participants regarding the potential importance of a technology and works as a standard setter.

**** OSF (Open Software Foundation) alliance**
OSF was first launched in 1988 by seven computer software companies including IBM, HP, DEC, and Siemens (Germany) for the purpose of close collaboration in software development and standard setting. This alliance has enjoyed favorable reception in software industries. OSF developed DEC, the industry standard for distributed computing across diverse platforms.

**** Unix International**
Unix International is the alliance of software companies created in 1988 under the leadership of AT&T and Sun Microsystems for the purpose of standardizing Unix operating systems. This alliance seeks to compete against the similar initiative of OSF (Open Software Foundation) launched by IBM, HP, DEC, and Siemens (Germany) that same year.

Every company has a limited amount of resources and skills and wants to get maximum profits from them. Cooperation helps achieve the seemingly contradictory objectives of maximum profits at minimum costs and low risks. Companies can build trust in each other and consequently acquire useful resources and skills easily through strategic alliances and consortium. Such cooperation facilitates the progress of a technology and encourages the development of new technology standards. New standards can help step up the game against competitors. Companies that can succeed in making a new standard through such cooperation are more likely to deliver better performances and realize greater profitability than their competitors.

When the overall size increases through cooperation, participant companies can exchange the details of standard technologies more easily. Collaboration in the development stage of a technology can wield a positive influence on the commercialization of the standard (Frontline Solutions, 2002). For example, the Bluetooth Special Interest Group and the GSM Association (GSMA) created a consortium for the purpose of commercialization of the *Bluetooth* technology. Gaining momentum from this cooperation, the Bluetooth technology is widely adopted in various application industries such as telecommunications, computing, automotive, industrial automation, and network industries. To date, there are more than 100 participant companies in this Bluetooth consortium, which helps provide short-range wireless specifications to the markets of the mobile device and wireless telecommunication industry at low costs. Ethernet was also developed from the same cooperation mechanism (introduced in Case 1).

**** Bluetooth**
Created by Ericsson in 1994, Bluetooth is the industry standard for wireless personal area networks (PANs). This technology was approved and officially announced as the standard on May 20, 1999 by the Bluetooth Special Interest Group. Participant companies in this alliance include Sony Ericsson, IBM, Nokia, and Toshiba.
Bluetooth seeks to replace wire-line USB (storage device), whereas Wi-Fi is mainly intended to substitute the Ethernet.

Case: Alliance forms for promoting the Ethernet (Communications Test Report, 2006)

THE *ETHERNET* ALLIANCE was launched in 2006 to expand the market size and applications of IEEE 802 Ethernet technologies. This alliance seeks to encourage the participant companies to adopt Ethernet technologies soon and fast track the entry of Ethernet products into the market. Moreover, it was supposed to provide resources to help implement the multivendor interoperability of IEEE 802 Ethernet products.
The major activities of this alliance include planning and developing new technologies within the Ethernet standards, demonstrating interoperability among applications and technologies, and spreading them through education. The founders of Ethernet Alliance include Agere Systems, Intel, Xilinx, and University of New Hampshire InterOperability Laboratory (UNH-IOL).

**** Ethernet**
Xerox, Digital Equipment, and Intel collaborated to develop Ethernet and acquired a patent in 1980. LAN (Local Area Network) had been developed as a proprietary technology by computer manufacturers. IEEE planned to establish a standard for LAN, and it was able to diffuse this technology successfully to many economies.

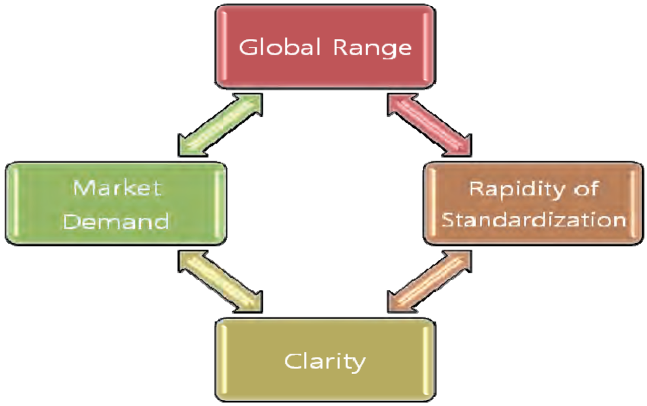
9.3 How to Organize for an Effective Collaborative Strategy

The critical issue in organizing cooperation is to find the right partners who can produce a positive synergy effect that can successfully resolve the current problems of the participants.

Most importantly, companies need to realize the importance of creating a constructive partnership. Many companies still regard other companies in the same industry as mere competitors instead of attempting to create a partnership with them. Therefore, they do not share knowledge and resources with each other. There are several criteria for choosing business partners.

First, companies need to forge partnerships to secure a synergy effect from the partnership. Compatibility is a critical concern in the synergy effect. Thus, partners should be found in the existing collaborative network so that their capability and reputation can be determined. Compatible orientation in strategy and vision is desirable for the synergy effect in an alliance. Each partner needs to possess the capability to provide technological complements, care about compatible standards, and own a similar organizational structure. Furthermore, partners need to create opportunities to learn from each other and to show courtesy in exchanging each other's knowledge. Risk evaluation is also a must in assessing the effect of the alliance (Salvatore and Casher, 2003).

Companies should consider the following factors in organizing a collaborative strategy: global range, market demand, rapidity of standardization, and clarity of the standardization process (TTA, 2005) (see Figure 2).



◀Fig. 9-2 Four Influential Factors in Organizing a Collaborative Strategy

1) Global Range

This issue deals with the geographical scope. The range of strategic alliance and consortium for the standard should match the scope of the market, since not all standards necessarily target the global market.

2) Market Demand

Companies need to verify whether the subject of the standard needs to satisfy the current market demand right away. The impetuosity for prompt market share wields an influence on the type of collaborative strategy. For example, a consortium tends to plan the prompt acquisition of market share and consequently cares about the market demand. Note, however, that alliances launched by a standard-setting organization seek to maintain the current market structure without sufficiently considering the market demand.

3) Rapidity of Standardization

Companies need to consider the time duration until they can complete the standardization process. A consortium seeks to take the initiative for the market share and cares a lot about agility. Nonetheless, cooperation for the international standard requires the approval of each member economy and takes a long time particularly translating and revising contracts with members. Therefore, the international standard lacks agility. Note, however, that the international standard-setting process has improved its speed to reflect the recent advancement of technologies.

4) Clarity of the Standardization Process

This issue deals with whether cooperation opens the standard-setting process and the products of this process to non-alliance members. A consortium tends to open the standardization process and the products to non-members. In contrast, cross-licensing involving patents among participants never opens the standardization process to non-members.

9.4 Types of Collaborative Strategy

Nowadays, start-up ventures and large companies in a cooperation assign different roles such as R&D, production, and marketing to each other in a collaborative relationship. Before, companies in a cooperation used to be in a hierarchical relationship wherein one company plays the leading role as headquarters and the other acts as subsidiary. Recently, however, cooperation has been distinguished from that in the past because companies tend to collaborate in a horizontal relationship to take advantage of each other's specialization and to realize a win-win situation (Doosan-Dongah, 2006).

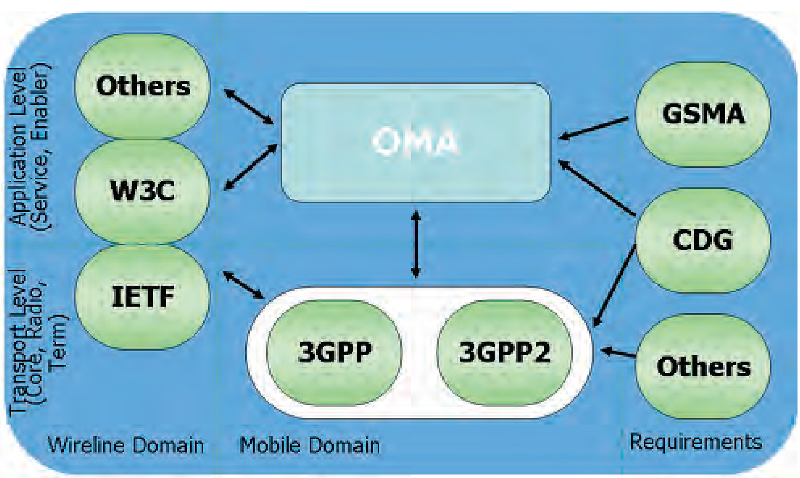
Among several types of cooperation, strategic alliance, cross-licensing, and consortium are the three most popular types of collaboration for technological standards.

9.4.1 Strategic Alliance

Strategic alliance means a contract wherein more than two organizations are committed to collaborating with each other. Many companies in an alliance are in a competitive relationship or are very much aware of each other's capabilities. Strategic alliance in the context of technological standard refers to licensing arrangements and straightforward, arm's length relationship. In a strategic alliance, there must be at least a commitment to cooperation along with major competitive dimensions such as the joint development and commercialization of a technology (Hill, 1997).

A representative example of strategic alliance for a technological standard is the commercialization of the compact disc (CD) player of the digital audio technology developed by Philips NV and Sony together. The fundamental CD technology was first developed by Philips in 1960. In 1979, Philips developed the prototype of the CD player and pushed for the commercialization of this product. Not long after, however, the company was faced with a fierce standard battle. JVC, SONY, and Telefunken released their own digital compact disc products whose technologies were not compatible with each other. Among them, Sony had technologies that were similar to those of Philips and shared the recognition that the global diffusion of the CD should be preceded by a standard specification. In 1979, these two companies made an agreement to cooperate on the commercialization of the CD system. This alliance gave birth to the Philips-Sony standard and conclusion of contracts with more than 30 companies for this technology specification. The manifestation of this specification is called "Red Book." This document stores the method of recording and reading the audio signals in the CD using the digital method and keeps the technological specification on the CD Player. The Red Book obtained international approval and established the status of the standard IEC-908 (TTA, 2009).

Another example of a successful strategic alliance is OMA (Open Mobile Alliance). As a forum that develops a technological specification and tests the compatibility of the specifications for the purpose of globalization of mobile data services, OMA (Open Mobile Alliance) was established in June 2002 under the leadership of OMAI (Open Mobile Architecture Initiative) created by Nokia and WAP (Wireless Architecture Protocol) Forum where Microsoft belonged (TTA, 2005). These forums sought to shift the attention of the computer industry from wire-line network standards to wireless Internet application standards. Forums such as OMA help activate the potential wireless Internet markets. For the sake of technological compatibility, OMA maintains a close relationship with the various standard-setting organizations involved in the mobile industry. To manage the collaboration with those organizations, OMA operates the “OMA External Liaison Program” to tap the cooperation of companies and standard-setting institutions. The organizations in the alliance include the Cooperation Agreement (ETSI, GSMA, MOBEY, IFPI, IAA, Liberty Alliance, Parlay, MPF, PayCircle, and CDG) and the Cooperation Framework (3GPP, 3GPP2, JCP, and ITU-T). More organizations such as IETF, JCP, W3C, MeT, MEF, TMF, OGC, and TIGA plan to join this effort. OMA takes advantage of M&A or alliance to acquire the specifications developed by other organizations or to consolidate its standard with theirs. For example, MMS (Multimedia Messaging Service) was created through the convergence of the requirements of GSMA and CDG, evolving to embrace the network layer specifications of 3GPP and 3GPP2. The relationship with external organizations can be summarized in Figure 3. The detailed explanations of OMS on the standard-setting work groups and process are introduced in Case 2.



◀Fig. 9-3 Collaboration between OMA and External Organizations (Source: TTA, 2005; p.1)

A strategic alliance offers many benefits. Most importantly, a strategic alliance helps diffuse the technology in the early stage of its life cycle. This feature helps the technology owner capture a market share earlier than its competitors. Such preoccupation is very critical in building up customer’s expectation regarding the new products. A successful alliance such as the case of the CD facilitates the sharing of each other's success factors and generates a higher volume of profits compared to working alone. Moreover, a strategic alliance encourages the alliance partners to diversify their own products voluntarily; thus increasing the production of complementary products. Such positive effects of a successful alliance also wield the positive impact of developing another technological standard and reducing cost as well as the risk of technological innovation.

Case: Standard Activities of the Open Mobile Alliance (OMA)(Bae, 2005)

For the sake of compatibility with other technological standards of other standard-setting institutions, OMS organized 15 work groups (WG) to deal with six major agenda for standardization (see Figure 4). Out of these 15 WGs, the Requirements WG, Structure WG, Security WG, and Interoperability WG handle the generic common agenda to secure compatibility.

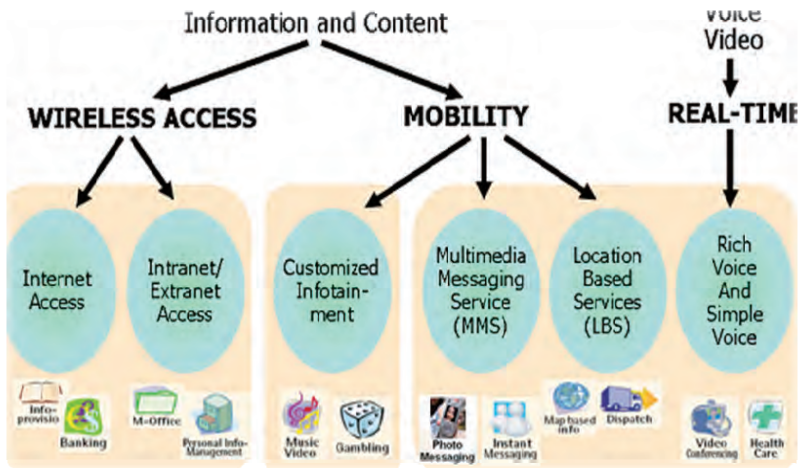


Fig. 9-4 ▶ Six Major Agenda for the Standards of OMA (source: TTA, 2005; p.2)

The standardization process of OMA goes through the following five phases (see Figure 5):

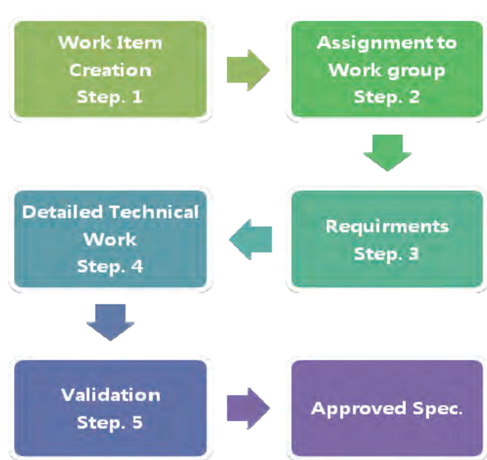


Fig. 9-5 ▶ OMA Standardization Process (source: TTA, 2005; p.4)

Case: Standard Activities of the Open Mobile Alliance (OMA)(Bae, 2005)

Step 1. Work item creation
Step 2. Assigning tasks to the appropriate work group
Step 3. Work group develops technical specifications.
Step 4. Work group completes the detailed specifications and implements them.
Step 5. Specifications are approved by validation.

These five steps can be summarized into the following three phases: Candidate Enabler Release (Step 1) - Approved Enabler Release (Step 2) - Interoperability Release (Step 3). The first phase (i.e., candidate enabler release) covers the first three phases of the five-phase model. The second phase (i.e., approved enabler release) tests the interoperability of the *OMA Service Enabler*. OMA confers the license to test IOP (Interoperability Process) upon its members. Enablers that passed through this second phase can ultimately be the solutions. The third phase (i.e., interoperability release) announces the results of the interoperability test. OMS prepares and announces the test reports on enablers whose end-to-end operability is proven through the previous two phases. Furthermore, OMA is supposed to introduce use cases that facilitate the user's understanding of technology.

****OMA Service Enabler**
OMA service enabler refers to a collection of specifications of a technology such as MMS, DRM, and browsing. It is simply called "Enabler."

9.4.2 Cross-Licensing

License is the right to use the technology belonging to an individual or an organization. Companies use the cross-licensing strategy to catch up with technology development fast. Cross-licensing involves the swapping of technologies by contract among two or more companies. Just like a generic license, cross-licenses have an effective duration.

Cross-licensing has numerous benefits. First, companies can reduce R&D expenses (in terms of both time and costs) by cross-licensing because they do not have to develop all the technologies at their own cost and through their own efforts; cross-licensing also allows companies to acquire the necessary resources fast. The development of new technologies is expensive and risky. The cross-licensing of already developed or commercialized technologies foregoes the costs of technology development (Kwon, 2007).

Second, companies can expand the application domains explored by the original technology. For example, Microsoft and Samsung made a cross-license contract in 2007 after lengthy negotiations. This cross-licensing covers a comprehensive range of technologies. Through this contract, Samsung was able to use the technologies of Microsoft on computers, set-top boxes, DVD players, camcorders, TVs, printers, and home appliances for the present and future. Furthermore, the distributors and customers of Samsung can apply the technologies of Microsoft to the products of Samsung. Meanwhile, Microsoft can use the patent portfolios of Samsung's digital media and computer technologies in present and future software development (eetkorea, 2007)

A representative example of an international license is CMLA (Content Management License Administrator) created in February 2004. Major members include Samsung, Agere, Ericsson, IBM, Intel, Microsoft, Motorola, Nokia, and Toshiba. This organization seeks to provide or keep the license of *Digital Rights Management (DRM)* version 2.0 on behalf of the Open Mobile Alliance (OMA) (CMLA, 2009).

In March 2008, LG's affiliate LG Display and Kodak entered into an agreement to cross-license the active matrix organic light-emitting diode (AM OLED) technology. Under the partnership, LG Display will pay royalties to incorporate Kodak's AM OLED technology in modules for use in a wide range of small to medium-sized display applications (please see Case 3 for the details).

**** Digital Rights Management (DRM)**

This intellectual property right seeks to protect the rights and interests of content providers by managing the comprehensive ranges of the life cycle of digital contents such as preventing piracy, charging fees, and managing invoices. DRM technologies include the digital copyright management that allows only authenticated users to access digital contents and pay for the services as well as the software for security and payment for the approval and maintenance of the copyright.

Case: LG Display & Kodak (cross-license)(Lee, 2008)

Kodak's active matrix *OLED* technology will be incorporated into next-generation portable media devices from LG Display. As the organic light emitting diode (OLED) technology pioneer, the Rochester, NY-based Eastman Kodak Co., disclosed that it has inked a royalty-bearing license contract for its yield-improving technology for active matrix OLED (*AMOLED*) modules with the Korea-based flat-panel display company LG Display Co., Ltd. The license allows LG Display to use the Kodak technology in a variety of small to medium-sized display applications such as mobile phones, portable media players, picture frames, and small TVs. The agreement also covers LG Display's purchase of Kodak's patented OLED materials for use in manufacturing displays. In February 2006, the companies began their relationship with a joint evaluation agreement. According to Mary Jane Hellyar, president of Kodak's display business, their goal is to see the AMOLED panels that have been co-developed continue to be around in the industry in 2008.

Fig. 9-6 ▶ AMOLED 3.0 inch (source: http://www.betanews.net)

LG Display believes that the agreement will help strengthen its small and medium-sized OLED business and bolster its position in the large OLED market in the long run.

Case: LG Display & Kodak (cross-license)(Lee, 2008)
**** OLED (Organic Light-Emitting Diode)** It is any light-emitting diode (LED) whose emissive electroluminescent layer consists of a film of organic compounds. The layer usually contains a polymer substance that allows suitable organic compounds to be deposited. This material is used for the display of small devices such as cellular phone, car audio, and digital camera. **** AMOLED (Active Matrix Organic Light-Emitting Diode)** An active matrix OLED (AMOLED) display consists of OLED pixels that have been deposited or integrated into a thin film transistor (TFT) array to form a matrix of pixels that illuminate light upon electrical activation, functioning as a series of switches to control the current flowing into each of the pixels. Backlight is not required. AMOLED refers to the technology behind the addressing of the pixels. AMOLED technology continues to make progress toward low power, low cost, and large size for applications such as TV.

9.4.3 Consortium

The standards of the information & communication technology (ICT) industry can be categorized into the following three types: (1) international (e.g., ITU), regional (e.g., ETSI), and national (e.g., TTA) de jure standard; (2) forum/consortium standard under the leadership of an alliance of companies, and; (3) market standard under the leadership of a specific product or service of a company.

A consortium is an *informal alliance* of firms, organizations, and (sometimes) individuals that is financed by membership fees for the purpose of coordinating technological and market development activities (Hawkins, 1999: 161). Consortia share certain characteristics; for example, they have maintained the following characteristics in the IT industry (Hawkins, 1999: 161):

- All consortia had their origins in the major ICT industry and market restructuring initiatives.
- All consortia tend toward the publication and/or implementation of technical specifications that have been developed or otherwise supported by their members.
- Consortia are aimed at transcending traditional sector boundaries between public and private networking by concentrating on specific product and service environments.
- Consortia employ working methods in their technical programs, which are generally very similar to SDO (Standard Development Organization) practices.
- Most consortia were established by core groups of founder members and made up mostly of multinational ICT supply firms and/or large national public telecommunication network operators.
- Consortia are accountable only to their own members, not to the public.

The forum/consortium standard is also called Forum Specification. *De facto standard* develops from either a single company's market dominance or from an alliance to develop and promote a particular technology favored by a coalition of firms (Axelrod, Mitchell, Thomas, Bennett, and Bruderer, 1995).

****De Facto Standard**
De facto standard pertains to both the forum/consortium standard supported by companies having the same interests by organizing a forum or a consortium and the market standard when a specific company secures market dominance without official endorsement or approval. MS Windows is considered the market standard.

Forum specification is often used by late starters that usually organize an alliance to compete against the winner after they lost in the battle for the de facto or market standard (Kexin, 2007). It is also an effective strategy when there is no dominant standard in the market and if numerous forums compete against each other for market leadership (Kexin, 2007). Such forum specification evolves into the market standard after capturing the market share, or it becomes the de jure standard with a petition to the standard-setting organization. Any consortium standard that survives the market competition ultimately captures the position of de facto standard. Once a technology secures market domination, there is no incentive for de jure standardization because it would mean opening up the market for other players (Egyedi, 2001). Therefore, a consortium standard can also be called potential standard; its products are called specifications (TTA, 2008). For this reason, companies organize consortiums for the fast acquisition of status of standardization.

9.4.3.1 Background of Consortia

Since the mid-1990s, industry-wide forum/consortium standardization pertaining to a particular technology has emerged as an important driver for a standard due to the divergence, convergence, and advancement of ICT. Companies of advanced economies had initiated the industry-wide consortium to acquire first-mover advantages in the core components, and such initiatives have intensified everywhere. As of May 2005, there are about 120 consortiums for standards (i.e., de facto standard organization).

There are three major reasons for the emergence of consortia:
1) Reaction of global companies of the US against the EU-based de jure standard-setting organizations
2) The Cooperative Research Act (US) promoted the cooperative R&D and consortium.
3) To prevent different regulations or incompatible technological standards of each economy from disrupting international trade.

The major reason for joining a consortium is related to the tipping effect (Gladwall, 2000). In the early stage of the competition, competitors demonstrate similar market shares. Note, however, that such small discrepancy eventually becomes too wide to overcome, and the market leader ultimately takes it all in the market. The critical point when this phenomenon starts to emerge is called the tipping point. If an organization misses the chance to join and develop the consortium that eventually seizes the market share, either the organization would not be able to overcome the handicap, or it would have to pay high costs to join or to secure compatibility with the consortium. IBM personal computers and Apple McIntosh were neck and neck before IBM ended up capturing the dominant market share.

After numerous technologies are released in the market, they compete against each other to become the standard in the market. A standard is determined with subsequent revision and negotiation. An interesting phenomenon during this process is that the best technology does not necessarily win the position of “the” standard. Sometimes, an inferior technology bags this position. The position of standard is enormous in the ICT sector. Note, however, that it is getting harder for a single company to secure such enormous position as technologies become networked to each other. Therefore, numerous companies organize a consortium and develop a technology together to win the standard or to check against the rival’s products. Cooperation among different economies or companies becomes crucial for the international standard.

9.4.3.2 Characteristics of Consortium Standards

Since the early 1990s, numerous consortiums have emerged and disappeared within a particular sector and have recently increased to more than 120 (see Table 1). Since market popularity is affected by specific features, functions, and interfaces, consortiums care about the market trends and demands. Companies in a consortium usually standardize the specifications of the products after organizing the consortium. Thus, a consortium standard is determined before products are released in the market. In contrast, the de facto standard is determined as more companies and users join a particular specification. For example, two consortiums competed in the DVD market before the actual products were developed. Those two consortiums were eventually unified into one consortium before the DVD was produced owing to pressure from the computer industry and Hollywood (Ko, et al, 2001).

Table 9-1 ▶ Examples of a de facto Standard Organization (source: TTA, 2005; p.16)

Tele-communication	Infrastructure (network)	ATMF, FSAN, IPv6, IPCC, MEF, MFA, MSF, OIF, RPRAWIMAX
	Access System	ADSL, Cable Modems, DSLF, DOSIS
	Mobile Communication System	CDG, DECT Forum, GSA, GSM Association, MCPC, mITF, OMA, PHS, MoU, SDRF, UMTS, WWRF
Information	Software	ASN, CBOP, CTFJ, DOPG, ECTF, FIPA, GGF, OMG, TM Forum, TOG, Ubiq Net, Web 3D, WfMC
	PC	1394 TA, DLNA, IrDA, MBOA, PCISIG, PCMCIA, PICMG, Salutation, STA, T-E, UPnP, USBIF
	LAN	Bluetooth SIG, FCIA-J, H2GF, Zigbee, LONMARK, OSGI, POF, WIMEDIA
Service	Internet	BCDF, EJF, ICANN, ISOC, JIF, LAP, MBA, W3C, WS-i
	Multimedia	Cidf, EMF, IDF, IMTC, OGC, TV Anytime Forum
	EC	AIM, AODEMA, Auto-D, CommerceNET, DISA, ECOM, EDIFICE, EMA, SSIPG, OASIS
	ITS	AMI-C, ERTICO, IDB Forum, ITS America, ITS UK
	Home Network	DHF, ECHONET, HAVi, Home PNA

A consortium facilitates international cooperation and enhances the efficiency of the standardization process. It also helps concentrate on a specific sector for a high level of specialization and speeds up the diffusion of a standard. A consortium standard is used to acquire the status of market standard because it is basically oriented toward market demands. Such market orientation continuously encourages the timely release of products and standards in the market.

A consortium also has several disadvantages. Most importantly, the standard specifications and process should be open to the market so that competitors can have easy access to this information and protect themselves against this standard technology. Moreover, a standard precedes the products (not the other way around); thus, there may be heated debates on the deficiency of fairness and comprehensiveness in the standard specification. In relation to this, problems loom with regard to the exclusivity, sustainability, and safety of IPR (Intellectual Property Rights). The pros and cons of a consortium are summarized in Table 2.

Decision maker of standard	Forum members (individuals/companies)
Validity of standard	Influence of forum and standard
Sectors of standard	Specific sectors
	Specific IT and applications
Critical Success Factors	- Influence of consortium - Number of participants - Participation of influential companies
Sequence of standardization	Standard specification → Product
Risks of standardization	When a standard specification cannot be materialized into products
Advantages	Agility, Market orientation
Disadvantages	Narrow scope of standard
Examples of standards	3GPPs, DVD, OMA

◀Table 9-2 Characteristics of a Consortium Standard (source: TTA, 2005)

The characteristics of a consortium can be further analyzed via a SWOT analysis (see Table 3). As discussed earlier, one of the strengths of a consortium is that the standard is determined in advance with reference to market demand; securing market acceptance also takes less time. Advancing into the international standard is highly likely including concentrating substantial investment on a specific technology because the consortia picked a particular technology in the beginning. A consortium is also flexible to the changes in market demands, showing more positive attitudes in reflecting the market's new requirements unlike the de jure standards. Therefore, a consortium standard tends to gain public favor when competing against de jure standards.

As an opportunity for a consortium standard, the consortium can make the standard attractive to the market. Thanks to such market orientation, the market has special interests in and pays attention to this type of standard. A consortium standard has oligopolistic control over the market, whereas the de jure standard (i.e., the national standard such as WIPI) has monopoly. A consortium standard is not always against or exclusive de jure standard, though. When these two types of standards (i.e., de jure and consortium standards) cooperate with each other, the resulting standards can wield greater market influences.

The weakness of a consortium standard is that there is no independent administration organization as in the de jure standard. Additional support is necessary for administration activities, related expenses, and maintenance services. Since the standard precedes the products, a consortium standard does not have any available test specification but starts from conceptual ideas. Moreover, the participation of numerous companies is expected to give rise to problems of lack of cooperation and difficulties in control.

As the major threat to a consortium standard, the standard can be too narrow because it already has the target market. Such narrow specification of a standard can cause difficulty in funding for R&D when the target market is not big enough.

Table 9-3 ▶ SWOT Analysis for the Consortium Standard (source: TTA, 2005)

S	-The market arrival time was shortened. -Flexibility/Non-bureaucratic -Global efficiency -Concentrated funding -Challenge to the official standardized organization -Reflects the user requirements on market fluctuation -Enables starting from a focused field
W	-Lack of test standard -Need for standard-related administration organization -No synergy effect -Lack of openness -Difficulty in demonstrating that it is a democratic or a legal procedure -Superficial approach -Necessity of supporting maintenance -Difficulty in the cooperation and control of a member
O	-High level of market interest -Competitiveness -Lead the standard that the market wants. -Cooperate and participate in the activity with the standardization organization.
T	-The visible target is the user of the standard technology. -There is a pusher, but no preventer. -Lack of synergy and arbitration -Cost

Questions and Discussions

1) What are the popular types of collaboration strategy across different industries?
2) What is the relationship between the de jure standard and consortium standards?
3) What are the risks and disadvantages of a collaboration strategy? How can we eliminate or reduce such problems associated with collaborative strategy?

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Chapter 10

Two Case Studies of ICT Standards

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10.1 Alliances in Standardization: Two cases of attempts at ICT standards in China and Korea

China and Korea are latecomers/newcomers in the international ICT standards regime. Both economies challenged the international standardization regime dominated by the USA, Japan, and EU. They have developed -- and are developing -- indigenous technologies in many domains of ICT, and they are trying to make their own technologies national and/or international standards.

In doing so, the battle lines of competition and collaboration are formed among many types of stakeholders including government agencies, universities, international standards organizations, domestic firms (varies depending on the location of a firm in the value chain, e.g., service operators, content providers, device manufacturers, etc.), international MNCs, and even foreign governments. This is where alliances are born; an alliance needs to be managed to avoid unnecessary competition and build collaborative partnership with those stakeholders that can potentially share the benefits of established standards.

Among the many attempts of China and Korea at standardization in the ICT sector, two cases of AVS (Audio Video Coding Standard) from China and WIPI (Wireless Internet Platform for Interoperability) from Korea are discussed herein.

10.1.1 AVS (China)

Digital coding compression technology is the core of all kinds of electronic devices with video and audio functions, such as digital television, IPTV, DVD players, laser disks, digital cameras, computers, and mobile phones. A famous, widely used standard for audio and video coding is MPEG (moving pictures expert group). Since audio and video standards define the specifications of coding specifically the decoding and processing of audio and video content in all kinds of digital and communication devices, their (economic) impacts on all electronic and communication industries are remarkably huge.

AVS refers to China’s new audio and video coding standard made by the Audio Video Coding Standard Workgroup of China (AVS Workgroup). The AVS Workgroup was sponsored by the Ministry of Information Industry and established in June 2002 as a consortium of over a hundred of universities, government organizations, and companies including foreign entities. At the time, Chinese manufacturers of electronic devices had been frustrated with the burdensome royalties paid to international licensing agencies. The royalty fee for every device using the MPEG2 standard was USD 2.50, which was too big a portion considering the low prices of Chinese products. Although China accounted for 90% of the world DVD player production, Chinese producers gained only “razor-thin profit margins partly because of license fees” (Suttmeier, et al, 2006, p. 11). For the AVS standard, electronic device makers will only pay CNY 1. China was estimated to realize savings of up to USD 1 billion by using AVS, assuming Chinese consumers buy 400 million units of digital televisions and DVD players in the next 10 years. In terms of its importance to China’s digital technology industry, AVS was listed as one of the three key information-related projects – along with 3G application and high-capacity computer development – in China's 11th Five-Year Plan in 2005.

The Workgroup developed the AVS video standard called AVS1.0, and the first high-definition decoding chip AVS101 was rolled out in 2005. In May 2005, the AVS Industrial Alliance was formed by 12 leading Chinese electronics manufacturers, content providers, and developers to promote the use of AVS. The progress of AVS toward becoming a national standard went as planned. As a national standard, it would rival MPEG4 and H.264[1]. Initially, AVS is an outcome of China's dissatisfaction with the burdensome royalties. Note, however, that there was another motivation that was high on the agenda: to establish it as an international standard challenging the MPEG4 standard. "With our own AVS standard, we will be able to develop China's audio video standards without being controlled by foreign patent holders," companies said (China Internet Information Center News, 2003).

Motorola would reportedly provide the Chinese market with full coverage of IPTV solutions with an option to support AVS; many state-supported companies were also committed to using AVS.

Since China is a big economy, however, any of its industries can hardly be united into one entity. Some IC (integrated circuit) companies were more committed to other standards such as H.264. Those that supported H.264 questioned whether AVS could really become a widely accepted standard, more specifically whether content providers would support AVS[2].

In September 2009, AVS was approved by the International Telecommunications Union (ITU) as an internationally recognized standard for audio video coding and decoding (TMT China, 2009). Currently, many firms manufacture AVS-based products including handset, terminals, IPTV, etc.

10.1.2 WIPI[3] (Korea)

With mobile phones nearing saturation and revenues from voice services stagnating or even shrinking, mobile carriers began to consider data service as the next revenue source. To hold their own against their competitors, carriers started developing mobile platforms on which mobile applications run. In Korea, there were three mobile carriers each of which used a different platform. Due to the presence of several mobile platforms, content providers (CPs) had to develop each matching version for the same content; hence the resulting unnecessary and duplicated investments and works. Increasing royalties paid to foreign platform providers such as Qualcomm (of BREW) was another consideration. Therefore, WIPI as the new

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1) MPEG4 is an upgraded version of MPEG2; H264 is another new-generation standard for digital coding compression.

2) This concern reminds us of the classic standard battle between Sony's Beta and Matsushita's VHS wherein producers of complementary products -- in this case, the movie industry -- played a critical role.

3) For details on WIPI, refer to H. Lee and S. Oh (2008). Political economy of standards setting by newcomers: China's WAPI and Korea's WIPI. *Telecommunications Policy* 32: 662~671.

platform based on domestic technologies was devised.

In July 2001, KWISF (Korea Wireless Internet Standardisation Forum) was established to initiate the WIPI. Participants included key players in the mobile industry such as the three mobile carriers, mobile phone manufacturers (e.g., Samsung Electronics), and Electronics and Telecommunications Research Institute (ETRI), a state-run R&D institute. In November 2001, the Ministry of Information and Communication (MIC) officially launched a project for the development of a new mobile platform standard and announced a schedule for the mandatory introduction of WIPI to the domestic market. In March 2002, WIPI 1.0 was ratified as a mobile platform standard.

Note, however, that WIPI faced major obstacles from various parties. In the private sector, SK Telecom ported its own platform (WITOP) in its newly launched phones. Providing its mobile platform BREW for KTF, Qualcomm considered the mandatory installation of WIPI an unfair practice violating the TBT (Technical Barriers to Trade) of WTO. The TBT Agreement "establishes rules and procedures regarding the development, adoption, and application of standards to prevent the use of technical requirements as unnecessary barriers to trade" (Cromer, 2005, para 9). TBT aims at eliminating such technical barriers to trade by requiring related economies to act in a transparent, non-discriminatory manner (DTI, 2004). Furthermore, Sun Microsystems raised IPR (intellectual property rights) issues with regard to the use of its Java technology in WIPI. In the public sector, the USTR (United States Trade Representative) expressed concerns over designating WIPI as an exclusive mobile platform. The planned mandatory use of WIPI was finally reported to WTO/TBT; the UN decided not to adopt a locally developed mobile Internet platform as a standard during the bilateral trade talks (Kim, 2004).

In April 2003, an agreement on royalty payment for the use of Java was reached with Sun Microsystems. This was a major setback considering the original goal of royalty-free technology. The government also withdrew its original plan of making WIPI the single national standard by compromising that any of the other platforms such as BREW could be loaded simultaneously in a mobile phone provided WIPI was installed. WIPI was eventually recognized mandatorily, but its failure to become the single national standard weakened its power considerably. WIPI installation accordingly started with all the mobile phones in Korea in April 2005, with WIPI loaded as a default in all the mobile phones used in Korea.

Since then, however, criticisms regarding the WIPI policy have continued. For example, when Nokia's vice president visited Seoul in May 2007, he claimed that WIPI was blocking Nokia's entry to the Korean market (chosun.com, 2007). In mid-2007, the Ministry of Information Communications (MIC; now known as Korean Communications Commission or KCC) allowed non-WIPI phones to be sold; thus lowering the prices of mobile phones. Since only 47% of all mobile subscribers used mobile Internet (including SMS), the mandatory installation of WIPI was deemed unfair by the consumers.

At the end of 2008, MIC announced that mobile communication companies can choose any type of platform. This seriously weakened the WIPI policy. Finally, on 1 April 2009, the mandatory adoption of WIPI was abolished. Such accelerated the entries of foreign mobile phones into the Korean market. In April, Nokia introduced its non-WIPI phone in cooperation with KTF. The long delayed entry of Apple's iPhone into Korea was finally realized in November 2009. As a big hit in the Korean market, iPhone has driven the growth of mobile Internet in Korea since then.China and Korea continue to push for their own standards. For example, Chinese ICT industries challenge the incumbent standards in every single domain of ICT sectors including TD-SCDMA (3G mobile communications), RFID, and home networking to name a few. Given China's immense market potential and accelerating global status, the rise of the economy even in the international standardization regime presents strategic tasks for both Chinese and foreign firms involved in international standardizations. For domestic firms, corporate interests do not always coincide with national interests. They do manufacture not only for domestic markets but also for export markets dominated by the incumbent standards of Western players. Should they follow the newly developed indigenous standards? Foreign firms and governments face a similar question. Should they forge partnerships with their Chinese counterparts to make a soft landing on the huge Chinese markets, or should they view them as rivals and compete against them to protect their standards?

Questions and Discussion

1) What other ICT standards are developed by China and Korea?
2) Why do China and Korea try to make their indigenous technology the standards? What are their motivations?
3) If you were the CEO of a domestic (Chinese or Korean) firm that is involved in a related business of AVS or WIPI, would you accept the standard or not? Why or why not? What would be your criteria for deciding whether to adopt the standard or not?
4) What obligations of the WTO TBT Agreement should be considered by government officials and standards bodies that seek to promote domestic technology through standards?

10.2. Innovation and diffusion of broadband mobile services in Korea*[4)]

10.2.1 Introduction

We can understand the development of mobile infrastructures as a dynamic alignment of actors and artifacts in three separate realms governing the growth of mobile infrastructure. These three realms define specific types of passage points through which the actor network must pass during the innovation and diffusion process related to mobile infrastructure. These three realms are: (1) innovation system; (2) market, and; (3) regulatory regime (Lyytinen and King, 2002).

Innovation system refers to any of the actor networks consisting of the interconnected sites, competencies, ideas, and resources that are able to develop new solutions and capabilities over time for mobile service based on research, experimentation, and development activity. **Market pertains to** the constitution of actor networks that produce telecommunication services or their underlying technologies by exploiting the technological capabilities defined within the telecommunication standards. Finally, **regulatory regime** refers to any type of authority (industrial, national, or international) that can influence, direct, limit, or prohibit any activity in the innovation and diffusion realm; thus imposing a set of constraints and associated inscriptions as to how actor networks can be organized.

10.2.2 Development of 2G CDMA Infrastructure in Korea

The development of CDMA-based 2G infrastructure in Korea was primarily enabled by close collaboration among actors in the regulatory regime and innovation systems. During this era, the actors in the market figure out what is possible with the new digital mobile phone technology.

In the regulatory regime, the Korean government played a significant role during the early stages of CDMA development through its industrial policy, standard selection, and support for the creation of an industry consortium of companies that will work with Qualcomm. First, the Korean government influenced the development of 2G infrastructures through its industrial policy toward the telecommunication industry. In the late 1980s, the primary driver of the Korean government's policy toward the telecommunication industry changed from national security to economic development. Such change in policy resulted in the gradual deregulation of telecommunication services particularly mobile phone and broadband Internet services. As part of such deregulation efforts, KMT was privatized and later renamed SKT in 1991. Afterward, the government organized an auction for the four additional 2G licenses in 1996. By creating five operators in a relatively small, fast growing, and virgin market, the government set the stage for fierce competition in the market among chaebols and enabled fast learning and effective market feedback between the market and the innovation system.

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4) *An earlier version of this case was published at the Journal of Strategic Information Systems (Yoo, Y., K. Lyytinen, & H.D. Yang , 2005).

A more direct role by the government was its decision to adopt an untried but potentially more efficient CDMA technology over the proven European GSM standard. Since GSM had already been established as a global standard with international roaming capability, operators and manufacturers in Korea preferred GSM to CDMA. Nonetheless, the government pushed for the adoption of CDMA because it offered the possibility of handling larger call volumes than GSM for the same spectrum. Moreover, Qualcomm's willingness to share advanced mobile technologies with Korean firms — a sharp contrast to the reluctance of the GSM community to share its intellectual property rights (IPR) with an outsider that did not bring its own share of IPR to the existing members — was an important factor that influenced the Korean government's decision to adopt CDMA.

Finally, the Korean government played an important role in the development and commercialization of CDMA technologies by working closely and neutrally with all industry partners. In 1993, the government set up a research fund for the development and implementation of CDMA technologies using the funds obtained from the license fees of five CDMA operators and managed by IITA (Institute of Information Technology Assessment) whose board consists mainly of executives from operators. The government also arranged the collaboration among ETRI, SKT, KT, and manufacturers from the beginning so that the time lag between technology development and commercialization could be minimized.

In the innovation realm, a consortium of Korean companies (Samsung Electronics, LG Electronics, Hyundai Electronics, and Maxon) along with KT and ETRI collaborated with Qualcomm to develop, design, implement, and field-test the main components of the network infrastructure and terminals from 1989 to 1996. Qualcomm had been developing spread spectrum radio technologies since the late 1980s as a challenger to GSM and TDMA; by the late 1980s, it already had 53 patents for radio protocols and MSM (mobile station modem). Nonetheless, it lacked a test site and a credible case for its untried technology. For Korean firms and ETRI, which could not find willing collaborators in the GSM community, Qualcomm provided an opportunity to gain access to mobile technology. Meanwhile, foreign manufacturers did not participate in this consortium because they primarily focused on the growing GSM market in Europe and Far East and worked on the next phase of services for the US. Korea Telecom (KT) played a significant role in managing the project, drawing on its extensive experiences in the management of large-scale development and commercialization of domestic TDX digital switching systems in the mid-1980s. It was also involved in the system architecture design and negotiated with Qualcomm regarding the royalties and IPR contracts. On the other hand, ETRI played an important role as mediator and arbitrator among the participating companies, which dispatched their researchers and engineers to ETRI and closely collaborated together with engineers from Qualcomm. ETRI acted as the main interface between Korean firms and Qualcomm in technology transfer concerning the CDMA radio interface. In the process, ETRI researchers' knowledge of developing domestic TDX digital switching systems in the 1980s proved to be a vital cog in commercializing CDMA. ETRI researchers modified the existing TDX architecture to adapt it to the CDMA network architecture on a large scale (including cell management, transfer, and roaming).

In the realm of the market, SKT successfully launched the world's first commercial CDMA service in 1996. Four other operators joined SKT (Shinsegi Telecom, KTF, LGT, and Hansol) by October 1997. All operators added a data services function in 1998 (14.4 Kbps) and upgraded in 1999 their network to IS-95B CDMA, which offered 64 Kbps access rates. During this era, these operators particularly SKT played a significant role in the development process. SKT organized a special taskforce for CDMA services by conducting field tests that provided critical feedback to the commercialization process. In particular, Samsung Electronics and SKT developed close relationships since the former offered the latest handset models only to the latter.

An important aspect of the market during this time was the fierce competitions caused by the relatively small market size, fast growth, and oligopoly market structure among operators. Backed by a chaebol, each operator could engage in the stiff price competition through large subsidies to consumers for the handsets and low call rates. All the operators aimed at the first mover advantage and consequently subsidized almost the full cost of a handset purchase for consumers. Such competition also facilitated the rapid market penetration of CDMA services through reduced prices, which in turn helped change the public image of mobile services from a luxurious item for wealthy people only to the handy replacement of public payphone for everyone. Once they have penetrated these new markets through low prices, operators had to differentiate themselves from their competitors by continuously offering new services. As a result, operators constantly experimented with new data services; successful data services were then quickly copied by other operators. During this period, the popular content services were short-messaging service (SMS) and Caller ID.

During this era, CDMA emerged as a key factor that aligned the interests of various actors. An outside actor, Qualcomm was enrolled as critical creator and owner of core technology capabilities. At the same time, in the early 1990s, Qualcomm needed manufacturers and operators that would be willing to take the risk of deploying unproven technology to the field; ditto for complementary innovations in the network architecture that would connect mobile devices to the telephone backbone network. The Korean government wanted to establish the mobile communication industry as a key strategic area for future economic growth and needed a partner that would help transfer key know-how on digital wireless communication technologies. ETRI and KT had experiences in developing network technology, which was complementary to Qualcomm's air interface layer of CDMA technology; they were looking for a willing partner that would transfer core technology for digital mobile communication. SKT, along with Korean manufacturers, provided key knowledge gained from the field in the course of deploying unproven technology on a large scale. Had Qualcomm's CDMA technology covered the implementation of all layers of mobile wireless infrastructure including both air interface and network interface (such as GSM), KT and ETRI's role would have been reduced considerably; whether they would have been able to coordinate the consortium as effectively as they did, we will never know. Through such enrollment, Korean manufacturers were motivated to acquire new technology capabilities and expand their operations to new business areas that were enabled by a growing, rapid exploitation of CDMA technologies in the Korean market and beyond. Similarly, had the Korean government been simply driven by the need of operators to upgrade their mobile infrastructure without learning the core technology, it would have licensed GSM technology. In summary, CDMA standards, through its narrow focus on air interface and relatively weak market position, allowed key actors to align their key interests; thus allowing them to collaborate effectively within a very short period of time.

10.2.3 Rapid Transition to Broadband Mobile Infrastructures

A transition from 2G to 3G is not a simple technological upgrade. Instead, it is a re-configuration of actor networks that enables the mobilizations of new technological, organizational, and financial resources. At the heart of such re-configurations of the actor network, CDMA standards played critical roles. Compared to the European GSM standard, CDMA standards offer a much weaker form of standardization (inscription) since they merely specify the radio interface and leave much of the network management and other service specifications open. As a result, the original span of the actor network shaped by the CDMA standards during the 2G era was much narrower than the one dictated by GSM standardization. This in turn provided more room and flexibility for technological and market experiments with new technological features and opportunities to enroll new actors (e.g., various content providers and m-commerce solution providers) as necessary. These new actors created a fertile ecology of experimentations with new service models and ideas without being constrained by CDMA standards. Therefore, 2G CDMA standards with its narrow specification allowed the coordination of interests and innovation activities between the actors in the market and innovation systems.

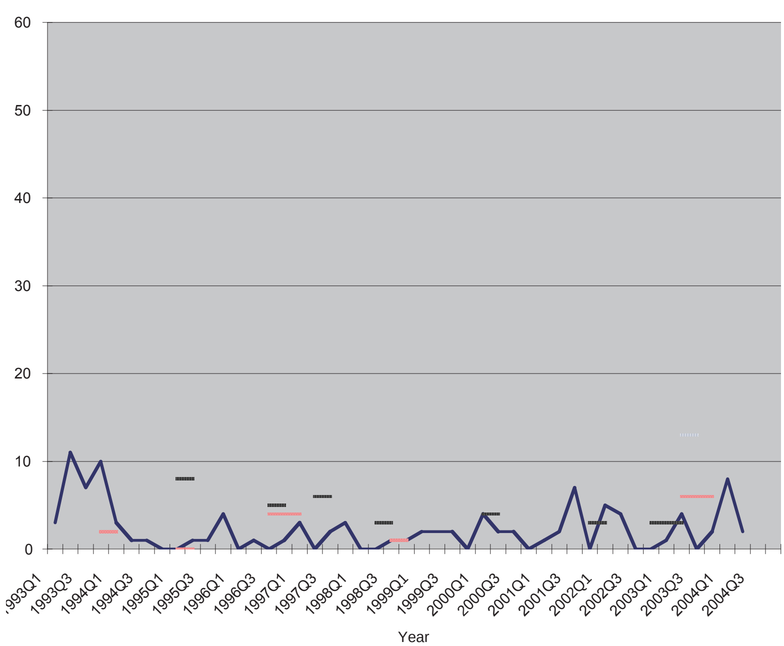
During this period, operators led innovations in mobile broadband services by introducing new multimedia data services such as Video on Demand (VOD), Multimedia Messaging Service (MMS), mobile broadcasts, downloading of musical dial tones and ring tones, animation characters, location-based services, and m-Commerce applications. They actively sought to build alliances with new actors such as financial institutions, broadcasting companies, content providers, and middleware solution providers to experiment with new types of value-added mobile services to customers. Through their knowledge of the market's response to new services, service operators had huge influence on the development of new standards.

As operators continued to seek new experiments, domestic handset manufacturers responded to those new ideas by pushing for innovations in new features of handsets with new functionalities such as color screens, digital music players, polyphonic ring tones, and digital cameras; they still relied on core technologies developed by Qualcomm, however. As a result, a few Korean manufacturers emerged as global players in CDMA markets. In particular, Samsung Electronics became the world's largest CDMA handset manufacturer and the third player in the global handset market next only to Nokia and Motorola. Samsung also developed its own CDMA 2000 chipset in early 2003. Similarly, LG Electronics gained substantial footing in the global handset market and emerged as the second largest CDMA handset manufacturer. Together, these two firms captured over 60% market share of the global CDMA handset market. These companies also leveraged their reputations in CDMA to penetrate the much larger GSM and W-CDMA markets. Globally, the GSM and W-CDMA phone sales of Samsung exceeded those of its CDMA sales.

An important sign of the increased influence of manufacturers and operators is their active participation in global 3G standardizations; thus creating another layer of linkage to the actor networks in the regulatory regimes. Korean manufacturers and operators are actively involved in critical global standard organizations including 3GPP (3rd-Generation Partnership Project), 3GPP2 (3rd-Generation Partnership Project 2), and ITU. Likewise, they actively engaged in the domestic standardization process through a domestic standardization body—TTA (Telecommunications Technology Association).

A shift in the locus of innovation activities from government-led coalitions to market-based experimentations can clearly be seen in Figure 1, which presents the number of events related to the evolution of mobile services in Korea from the end of 1992 to the second quarter of 2004. It shows the breakdown of events over time across the three different realms. In particular, it clearly demonstrates that actors in the regulatory regime played significant roles in the early phase of the 2G era, but that their importance diminished over time. On the other hand, actors in the innovation systems recorded a significant number of activities starting from the third quarter of 1994 when the second phase of CDMA commercialization began. Activities in the innovation realm peaked again from late 1999 through 2002 as they tried to evolve into 2.5G and 3G systems. During the same period, we saw a similar pattern of activity in the market; this suggests a close connection between the innovation systems and the market through feedback and feed-forward loops

Fig. 1▶ Frequency of events related to mobile services innovation in Korea (1993 ~ 2004)



between the two realms. The activities in the market continued to grow from the beginning of the 2.5G era, indicating that actors in the market play important roles in the innovation of mobile broadband services. This also suggests that innovations in the 3G era are as much a business innovation as a technical one.

The integration of Internet data service with mobile phone service also required the emergence of new actors. In particular, value-added solution providers for multimedia content have emerged as an important group of actors in the innovation system; they connect content providers to mobile operators' networks. While operators want to maintain exclusive relationships with these solution providers, most of them deal with all three operators; thus reflecting their growing bargaining power. At the same time, a new set of standards governing mobile Internet data access, content delivery, and transactions also emerged as critical obligatory passage points. This part of the protocol stack forms a key technological component of and obstacle to the successful implementation of universal mobile data services. During the late 1990s, an open, limited, and not very successful WAP (Wireless Application Protocol) and a proprietary but successful i-Mode emerged as standards governing major parts of this protocol stack. As service providers and content providers began offering more advanced data services enabled by the increased transfer speed and falling costs, all three operators in Korea implemented their own proprietary platforms to run Internet-based applications (see Table 1). To develop a general standard that supported all three operators, the Korea Wireless Internet Standardization Forum (KWISF) was formed as a body representing all three major operators, major handset manufacturers, TTA, and ETRI. KWISF developed a new standard for mobile Internet called WIPI (Wireless Internet Platform for Interoperability), and all three operators decided to adopt it. Drawing on Sun Microsystems' open Java standard, this standard was later adopted as part of the W-CDMA standards by 3GPP in May 2002. Other global players including Sun Microsystems, Microsoft, and IBM have also joined the alliance. On the other hand, Qualcomm has been promoting its own mobile Internet data access standard called BREW (Binary Run-time Environment for Wireless). Since the European GSM market was already dominated by Java-based platforms, Korean operators' decision to adopt WIPI instead of BREW signaled a significant shift in the dynamics and configuration of the actor network.

◀Table 1 Proprietary Mobile Internet Platforms for Broadband Data Services

Service Providers	Mobile Internet Application Platform
SKT	GVM
	SK-VM
KTF	BREW
	MAP
LGT	KVM

The emergence of a new stack of standards as key obligatory passage points and the increasing power of manufacturers prompted the Korean government to adopt multiple standards for 3G services, granting licenses to award W-CDMA licenses to SKT and KT FreeTel (KTF) and CDMA 2000 to LG Telecomm (LGT). Korean manufacturers have always wanted to enter a much larger GSM-based global market as part of their export-driven national economic strategy; they saw the domestic W-CDMA market as an essential part of fully leveraging the reputation of Korea as a hotbed of mobile service innovation in the global market.

The increasing strategic importance of the mobile Internet data standard also resulted in the weakening power of Qualcomm in the broadband mobile services arena. While Qualcomm remains a dominant player in the CDMA2000 domain due to its huge IPR pool and excellent chip design capability, several of its competitors have begun to produce compatible chipsets including Samsung, Texas Instruments, and Nokia. As a sign of its dwindling influence, Qualcomm has had to deal with increasing conflict with some Korean operators over the best evolutionary path toward CDMA2000. While Qualcomm prefers to follow the evolutionary path of CDMA2000 1x → CDMA2000 1xEV-DO → CDMA2000 3x, LGT plans to skip CDMA2000 1xEV-DO and wants to implement CDMA2000 1x EV-DV directly, which is opposed by Qualcomm.

Questions and Discussion

1) What are the major differences between the 2G and 3G eras in terms of the major actors of the Korean mobile industry?
2) What are the positive and negative consequences of the bigger influences of network operators in Korea?
3) If you are the CEO of a network operator in Korea, how would you deal with the new challenge posed by the smartphone services initiated by Apple's iPhone?

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Asia-Pacific
Economic Cooperation

Annex A.

Nine Brief Cases: Standards Make a Real Difference

Contributed by Standards Australia
(http://www.standards.org.au/cat.asp?catid=146)

APEC Sub Committee on Standards and Conformance
Education Guideline 3 – Textbook for Higher Education
Standardization : Fundamentals, Impact, and Business Strategy

Case studies supplied courtesy of Standards Australia www.standards.org.au

A.1 Roads and Transport: AS 4962 Electronic Toll Collection

ONE E-TAG FOR ALL TOLL ROADS

"The main focus of AS 4962 is to facilitate interoperability …Toll users now have the ease of only one account and one tag that can be used Australia wide …"
Douglas Quail, Austroads

Key Benefits

- ~ Convenience
- ~ Reduction of OH&S risks
- ~ A common platform to build innovative systems
- ~ Minimises research and development costs
- ~ Increased knowledge from committee participation

The Australian Standard® for Electronic Toll Collection (AS 4962) provides an agreed scheme of interoperability for toll operators, electronic fee collection system integrators and equipment suppliers.

Douglas Quail represents Austroads (an association of Australian and New Zealand road transport and traffic authorities) and is the chair of Standards Australia's Electronic Toll Collection Committee. He explains the benefits of offering road users a convenient, standardised method of paying for road and bridge tolls throughout Australia.

"As tollways were introduced to Australian roads, it became necessary to provide a universal means of payment that would be convenient for road users and efficient for tollway operators. The best method to achieve this was to bring the industry together and develop an Australian Standard that all of industry agreed to.

"A lot of planning, debate and healthy discussion went into the development of the national Electronic Toll Collection Standard (AS 4962). This was largely because the proposed shift to one Standard across the economy would require operators to revisit their existing arrangements. In the end, the importance and the value of having a single system throughout the economy prevailed.

"The main focus of AS 4962 is to facilitate interoperability and make electronic toll collection much more attractive to road users. Apart from the convenience of no longer having to 'stop and pay', toll users now have the ease of only one account and one tag that can be used Australia wide. This is particularly convenient for organisations that have a large fleet of vehicles.

"This interoperability also allows customers to use roads they would not ordinarily use. For example, they may go to work everyday using a toll road but when they are on holidays or out and about travelling they are more likely to use a toll road if they have the convenience of an electronic tag.

"Road operators benefit from AS 4962 because equipment procurement and reliability can be assured through use of systems that are tried and proven. It also allows them to effectively manage the flow of traffic by monitoring the average travel time of tagged vehicles so they can better serve the travelling public.

"The introduction of electronic toll collection systems in accordance with AS

4962 has also had a positive flow on effect for toll collection staff. Instead of working in tollbooths surrounded by cars and trucks, staff now have a more pleasant office environment dealing with customer enquiries and accounts.”

A.2 Consumer Products: AS/NZS 2063 Bicycle Helmets

WEARING HELMETS SAVES HEADS

"You never think you are going to need a helmet and on the day you do, you want it to perform exactly the way mine did."
Alan Cadogan

The Australian Standard® for pedal cycle helmets (AS/NZS 2063) specifies construction and basic performance requirements to provide wearers with protection against head injury from hazards associated with cycling.

In the early 1990s NSW introduced laws making it compulsory to wear a helmet when cycling. The importance of a properly fitted bicycle helmet in saving lives and minimising serious injuries cannot be emphasised enough.

Alan Cadogan is a husband, father, and Manager of Project Development with the City of Sydney. He explains how wearing a bicycle helmet conforming to AS/NZS 2063 saved his life.

"I ride my bike to work quite a lot, but I'm no daredevil. I try to stick to all the road rules; I wear a bright fluoro top and an approved helmet. I chose this helmet after doing some research. I read up on bike helmets, what I should look for, how they work and which one would be best for me. This helmet was a bright colour, a good fit, had lots of ventilation holes and it complied with Australian Standards, which was very important.

"You never think you are going to need a helmet and on the day you do, you want it to perform exactly the way mine did. I was riding to work on the 29th of November 2004 and came along a road where there was a roundabout. I thought a car that was coming into the roundabout was going to stop but at the last minute I don't think he saw me. The car hit my bike side on, causing me to fly over my handlebars, do a pretty impressive somersault and land on my left shoulder and head. It hurt an awful lot I have to say. Luckily people stopped, came to my assistance and called an ambulance.

"I thought I had broken my upper arm because that's where the pain was but I later found out it was my left scapula. My doctors were pretty amazed by my injuries.

"When I looked at my helmet some time later, I noticed a crack from the crown all the way down the left hand side. It's pretty impressive and that helmet is the reason there isn't a crack from the crown of my head all the way down the left side.

"I would be very happy to buy the same kind of helmet, very very happy to!"

Key Benefits

- ~ Reduction of injuries
- ~ Consumer confidence
- ~ Assistance with purchase decisions
- ~ Guidance to manufacturers
- ~ Assists government to craft laws that protect the community

A.3 Food: Food Safety

KEEPING OUR FOOD SAFE

"Standards Australia brings together experts in the field to develop Australian Standards®… they provide independence, credibility and ensure alignment with International Standards thereby facilitating compliance with export trading partners."

George Davey, NSW FA

Key Benefits

~ Consumer confidence
~ Public health and safety
~ Facilitates exports and international trade
~ Promotes Australian primary production

Standards Australia, Food Standards Australia and New Zealand (FSANZ), NSW Food Authority (NSWFA) and the National Association of Testing Authorities (NATA) work together to ensure the safety of the food we eat.

George Davey is the Director General of the NSW Food Authority (NSWFA) - the agency responsible for food safety from primary production to point-of-sale in NSW. He chairs or sits on many committees domestically and internationally relating to food safety and microbiology, and is the chair of the Food Standards Sector Board. Here George explains the network keeping our food safe and wholesome.

"Food Standards Australia New Zealand (FSANZ) is the national body for setting standards for food composition, labelling and contaminants. They do that in consultation with NSW Food Authority (NSWFA) and similar organisations responsible for implementing these standards in Australia and New Zealand.

"If that standard requires a test method, Standards Australia is called in to develop a suitable test methodology.

"Standards Australia brings together experts in the field to develop Australian Standards® for methods of analysis. It's a good mechanism. Individual agencies like ours don't have the resources or the capacity to do that and Standards Australia is recognised as the expert coordination body in the field. They provide independence, credibility and ensure alignment with International Standards thereby facilitating compliance with export trading partners.

"So you've got a standard setter, an implementer and a test method developer. The National Association of Testing Authorities (NATA) then accredits laboratories for their ability to undertake the Standards Australia test methods.

"An example would be testing for indicators of pollution in shellfish. FSANZ prescribes standards to specify an acceptable level of E. coli in oysters, Standards Australia develops the test method to check the levels of E. coli in oysters and NATA accredits laboratories to be able to do that testing.

"This process is critical for the oyster industry and public health.

"It's important that Standards Australia has regulators like NSWFA and FSANZ on their standards development committees as well as laboratory people and NATA, because we are able to guide them in terms of what is needed.

"Everyone that should be there will be there. That's the value of the Standards Australia committee process - all the key stakeholders contribute to the process. So at the end of the day we're all committed. Everyone has been through the journey together, we all sign off together."

A.4 Geographical Information: AS/NZS ISO 19115 Geographic information - Metadata

FIND IT ANYWHERE

"Metadata is about giving geographical features a common label … Because the Australian Standard is exactly the same as the International Standard, consistency extends across the globe."
Chris Body, Geoscience Australia

Key Benefits

~ Platform for innovation
~ Consistency across communication mediums
~ International compatibility
~ Public safety
~ Guidance for software designers

The Australian Standard® for Geographic Metadata (AS/NZS ISO 19115) provides information about the identification, extent, quality, spatial reference and distribution of digital geographic data.

Chris Body is the Information Standards Coordinator at Geoscience Australia, an Australian Government Agency that provides spatial information to help manage our domestic resources and support informed decisions about land use, development and emergency management.

"Years ago, when governments, businesses or emergency services wanted to know where to go and how to get there, they would turn to a map or street directory. Now they rely on spatial information that is created using software and stored digitally for downloading to computer screens. Consumers have similar expectations as they come to rely on satellite navigation systems in their cars. As a result, there was a need to come up with a new way of describing geographical data that would allow these new tools to develop."

This 21st century version of geography relies heavily on Standards so that users can be sure that information about a feature on one map has the same characteristics as the same feature on another map or can be searched across many different repositories. The key Standard in the field is AS/NZS ISO 19115:2005 Geographic information – Metadata.

"Metadata for us is about giving geographical features a common label. For example, we want a building to have the same characteristics whenever it comes up on a screen or in any other spatial data source. The same name, street address, latitude and longitude, height above sea level, and so on. The aim is to obtain consistency and avoid confusion.

"Because the Australian Standard is exactly the same as the International Standard, we can be sure that this consistency extends across the globe. There are 61 economies doing something similar to us. The data is drawn into a seamless system based on easily recognised formats. This is obviously preferable to doing it 61 different ways."

Systems based on 19115 metadata have made great contributions to Australia in recent times.

"During the equine flu outbreak, geospatial information helped monitor the infected areas. Similar information has been used during bushfire emergencies to allow controllers can keep track of the path of the fire and where their crews are located."

A.5 Certification: AS ISO/IEC 17025 General requirements for the competence of testing and calibration laboratories

STANDARDS PUT TO THE TEST

"If I make a recommendation about a piece of equipment and I base that recommendation on the equipment's performance against the relevant Standard, this gives me a high level of confidence that I am right."
Hasib Congo, Hydro Tasmania

Key Benefits

~ Efficiency of equipment
~ Maintenance cost savings
~ Quality assurance
~ Reduction of OH&S risks

The Australian Standard® for testing and calibration laboratories (AS 17025) sets out general requirements to ensure laboratories are able to competently test and calibrate their equipment against relevant Standards.

Hasib Congo is a Senior Electrical Engineer with international consulting firm, Hydro Tasmania Consulting, providing expert engineering services in power engineering areas. He is also in charge of Hydro Tasmania's electrical equipment testing laboratory, which is accredited by the National Association of Testing Authorities (NATA). Hasib is also a member of the NATA Council.

Hydro Tasmania is a government business enterprise owned by the state of Tasmania. For around 100 years, 'the Hydro' has built and maintained dams, pipelines, power stations and transmission networks to provide hydro power to Tasmania. More recently, the organisation has moved into renewable energy, including wind power, and is now responsible for half of Australia's electricity produced from renewable energy sources.

Hasib's work in the testing laboratory gives him a unique perspective on Standards.

"Accreditation, testing and Standards go hand in hand. Our laboratory is regularly tested and accredited against AS ISO/IEC 17025 and against AS ISO 9001 Quality management systems. But it is not a matter of being tested and accredited and then forgetting about it. NATA comes back every two years to look at us again.

"We also have to ensure that we maintain a laboratory that can support calibration and testing services for electrical equipment to the level required not just by 17025 and 9001, but also by other Standards applying to instrument transformers of different types and electricity metering equipment.

"We believe in Standards and our people need them each and every day. If I make a recommendation about a piece of equipment and I base that recommendation on the equipment's performance against the relevant Standard, this gives me a high level of confidence that I am right.

Standards can only be a back-up to your own training and experience but it is very comforting to have them there.

“As well as calibrating and testing Hydro’s own equipment, we tender for other work as well, and this usually means going on site, sometimes interstate or overseas. In each case, the relevant Australian Standards are an essential part of our tool kit. Sometimes, when equipment is imported and we may only know that it complies with an American Standard, we then have to test it against the Australian Standard.”

A.6 International Trade

THE BUSINESS CASE FOR STANDARDS IN APEC

"If you have an International Standard, then you have one Standard accepted everywhere, removing impediments to trade."
Elizabeth Morris, DFAT

Key Benefits

~ Promotion of international trade
~ Reducing technical barriers to trade
~ Assisting growth and prosperity of developing APEC economies

Elizabeth Morris from the Department of Foreign Affairs and Trade (DFAT) has been involved in raising awareness of the business case for International Standards in developing economies by energising industry in those economies to take a greater role in standardisation.

Elizabeth is Executive Officer of the Trade Development Division's APEC Task Force. Asia-Pacific Economic Cooperation (APEC) is the premier forum for facilitating economic growth, cooperation, trade and investment in the Asia-Pacific region.

Elizabeth explains how Standards Australia has helped to facilitate trade by assisting APEC member economies to build their capacity to engage in International Standards Development.

"If you have an International Standard, then you have one Standard accepted everywhere, removing impediments to trade. It's particularly important for the APEC economies as a lot of them are manufacturers.

"Standards Australia is strongly represented internationally and these connections are critical. Standards Australia's people have high standing in the APEC region for their capacity to work closely and successfully with a lot of these organisations.

"One such project involved DFAT, the Department of Industry Tourism and Resources and Standards Australia undertaking a series of workshops in China, Indonesia, the Philippines, Vietnam and Thailand in 2004 - 2005.

"We took case studies that were developed by Standards Australia and regional standards bodies and used them to illustrate issues such as the relationship between Standards and trade, prescriptive Standards versus performance Standards and the benefits of International Standards.

"We worked closely with the standards organisations in APEC economies and on their advice, we covered a range of different industries such as wood-based products, electrical goods, textiles and automotive products.

"The seminars gave local business organisations the opportunity to develop their understanding of how to work effectively with government and standards organisations to facilitate the adoption and implementation of International Standards, improve the business environment and achieve their own objectives.

“It can’t just be government making Standards: there has to be input from business, the industry associations and the consumer bodies.”

A.7 Renewable Energy: AS 4086 Secondary Batteries for Stand-alone Power Systems

SOLAR ENERGY FOR A CLEANER FUTURE

"Standards form the basis for much of the work performed in any industry … they are used to support the development of training, accreditation, safety policy and set industry best practice."

Jeff Hoy, JP Energy Technology

Key Benefits

~ A common platform to build innovative systems
~ Minimise research and development costs
~ Reduction of OH&S risks
~ Guidance for renewable energy industry
~ Increased knowledge from committee participation

Australian Standards® for stand-alone power systems and associated equipment provide requirements for the safety, design, installation and maintenance of renewable energy power sources.

Jeff Hoy is the owner and operator of JP Energy Technology, a supplier of off-grid electrical energy solutions. Over the past decade a range of Australian Standards for stand-alone and grid-connect power systems have been developed in response to the needs of this emerging industry.

"Since the early '90s, a large number of domestic and small commercial sites have opted for renewable energy sources as off-grid electrical supply options. PhotoVoltaic modules together with small wind and micro-hydro, have increasingly become competitive.

"As the industry grew, RAPS, now called SPS-Stand-alone equipment such as photoVoltaic (PV) modules, voltage regulators, inverters and battery chargers have made great advances in quality and reliability.

"The industry saw the need for training packages and recognised that one of the main industry safety issues were large battery banks.

"Standards Australia was approached by the industry association to help develop Australian Standards for the SPS industry.

"The initial and continuing development of Australian Standards requires voluntary effort from many small businesses and individual contractors.

The end result is a distillation of industry experience and knowledge that will ensure current and future industry participants see these Standards as an asset rather than a set of 'rules'.

"In 1997, AS 4086 Secondary Batteries for use with stand-alone power systems was released, and in 1999 and 2000 the AS 4509 series for Stand-alone Power System safety, design and installation was introduced.

Since then we have seen the development of a number of other Australian Standards applicable to our industry.

"Standards form the basis for much of the work performed in any industry. For an emerging industry they are more influential as they are used to support the development of training, accreditation, safety policy and set industry best practice."

A.8 Infrastructure security: AS/NZS 4360 Risk Management

SECURITY FOR OUR CRITICAL INFRASTRUCTURE

"Being able to draw on AS 4360 and follow the main elements of the risk management process was extremely beneficial."
Chris Allen, Sydney Opera House

Key Benefits

~ Improved identification of risks
~ Public safety
~ Protecting public property
~ Improved corporate governance
~ Better planning and allocation of resources

The Australian/New Zealand Standard® for Risk Management (AS/NZS 4360) provides a guide to managing risk and may be applied to a wide range of activities, decisions or operations of public, private or community enterprises.

It is aimed at improved decision making and planning, better identification of opportunities and threats, better allocation of resources, pro-active management, improved compliance with legislative obligations and better corporate governance.

Chris Allen is Head of Security at one of Australia's most precious icons, the Sydney Opera House. Chris took on this role in 2003, not long after protesters climbed the sails of the Opera House, painted "NO WAR" and made international headlines. He is also a representative on the panel of the National Centre for Security Standards.

The "NO WAR" incident, which followed "9/11" and a number of reviews by ASIO and the NSW Government, was an important catalyst for a security upgrade at the Opera House.

Here Chris talks about the role AS 4360 played in bringing about important change:

"My first task was to prioritise the core vulnerabilities of the Opera House and determine a strategy for change," he said.

"At the core of being able to sell the changes to Government was being able to say we had taken a legitimate approach and used a logical Standards based decision-making process. The primary document for me back then was AS 4360. Further support of this came from ASIO's review, which rigidly adhered to the AS 4360 principles.

"The work was ground breaking but not without difficulties. Being able to draw on AS 4360 and follow the main elements of the risk management process was extremely beneficial. By consulting, establishing the context, identifying and analysing the risks, we were able to identify the training for personnel necessary to protect a domestic icon and the public.

"While recognising the importance of technology, good personnel are at the core of any successful initiative.

"You can put all sorts of fantastic technology and exorbitant amounts of money into any site you like, but if the human operating the job is not up to it, it's just going to be ineffective.

“Equally important is the need for senior decision makers to be qualified and adhere to Standards that are set domestically.

“At the end of the day, if we have a major incident in this economy anywhere, the people in charge have to be able to put their hands on their hearts at a Coronial Inquest and say they provided advice in accordance with domestically recognised Standards and that the people who provided that advice are qualified to domestically recognised accredited training.

“If we can’t do that then we’re not going to be providing the right types of strategies to protect the public, it’s as simple as that,” Chris said.

In 2009, AS/NZS ISO 31000-2009 Risk Management – Principles and Guidelines replaced AS/NZS 4360-2004 Risk Management as the leading resource available to Australian directors, top level executives and others responsible for managing an organisation’s risks and achieving objectives.

AS/NZS ISO 31000 is a direct adoption of the new International Standard, which is based significantly on the 2004 edition of the Australian/New Zealand Risk Management Standard.

A.9 Training Simulation: AS/NZS ISO 9001 Quality Management Systems Requirements

SIMULATION SOLUTIONS EXPORTED TO EU

“When we were able to assure them our products where designed to Australian Standards that were 100% compatible with relevant ISO and IEC Standards - we were able to do business.”
Mike Hannel, SYDAC

Key Benefits

~ A common platform for building innovative systems
~ Guidance for engineers and designers
~ Assists in selling into international markets
~ Reduction in research and development costs
~ Public safety

The Australian and New Zealand Standard® for Quality Management (AS/NZS ISO 9001) specifies requirements for organisations needing to demonstrate their ability to consistently provide products that meet customer and applicable regulatory requirements.

SYDAC specialises in innovative simulation-based solutions. It services an international client base across a broad range of industry sectors, including defence, manufacturing, food, mining, pharmaceutical, automotive, rail, transport and utilities. Its primary solution areas include simulators for operator training, the design of new equipment and processes using virtual techniques and online situational awareness systems.

The company produces full immersion training simulators for a wide range of training applications including for operators of transport vehicles, mining and construction equipment and complex industrial facilities. These simulators provide a virtual environment in which the trainee can be instructed in the correct procedures under routine and abnormal conditions.

SYDAC Chairman, Mike Hannell explains that the adoption of International Standards has been vital in winning overseas contracts for the company.

“In bidding for the supply of simulators into the UK market we found they were not interested in buying anything that did not comply with their established EU Standards.

“When we were able to assure them our products were designed to Australian Standards that were 100% compatible with the relevant ISO and IEC Standards, such as IEC 60065 Audio, video and similar electronic apparatus – Safety Requirements, we were able do business.”

SYDAC found that International Standards are just as relevant with business systems as they are to technical compliance.

Mike explains that a major concern in SYDAC’s dealings with the London Underground was their internal quality systems.

“Once we could demonstrate our quality systems had been independently assessed as being compliant with AS/NZS ISO 9001 Quality Management Systems -

Requirements, and assure them that this Standard was identical to the ISO Standard, they were satisfied that we were the type of company that they could do business with."

Annex B.

The Role of the APEC Specialist Regional Bodies (SRBs)

Standardization : Fundamentals, Impact, and Business Strategy

APEC Sub Committee on Standards and Conformance
Education Guideline 3 – Textbook for Higher Education

B.1 Why Are the Elements of the Standards and Conformance Infrastructure Important?

The Standards and Conformance infrastructure, comprising metrology, standards and accreditation, and conformity assessment impact on the simplest daily activities, such as the accuracy of an alarm clock, the way the seatbelts in a car operate, and the safety of food.

The same technical infrastructure also underpins the complex technologies and industrial processes that drive economic growth.

Everyday commercial transactions and international trade could not take place without the support of a metrology, standards and accreditation and conformity assessment infrastructure.

It provides the essential framework for industry and government to maintain domestic and foreign confidence in goods and services. It is also the key to enhancing global competitiveness, attracting investment, and fostering and supporting innovation.

Why does the standards and conformance infrastructure have such a pervasive effect on people's lives? What are the roles of the key technical infrastructure bodies identified by APEC.

B.1.1 METROLOGY

Metrology (the science of measurement) is an integral component of the technical infrastructure value chain. Traceability to national measurement standards is fundamental, for example, to the optimisation of production, disease diagnosis and health care, food safety, forensic science, environmental monitoring, occupational health and safety, and consumer confidence and protection.

National measurements standards provide the basis for other conformity assessment activities in both the regulatory and voluntary sectors.

Many metrological requirements are supported by legislation or regulation. These aspects become part of an economy's "legal metrology system." Metrology is also fundamental to measurement of traded products.

B.1.2 STANDARDS

Standards include specifications, regulations and procedural requirements. Adherence to standards can be either to voluntary documents or to mandatory regulation and laws. Standards are written by international organisations, national standards bodies, regulatory authorities, and trade and industry associations, with the active participation of stakeholders including technical experts from industry, government, consumer groups and other affected parties.

B.1.3 ACCREDITATION AND CONFORMITY ASSESSMENT

Accreditation is a procedure by which an independent authoritative body (accreditation body) gives formal recognition that a (conformity assessment) body or a person is competent to carry out specific tasks. Accreditation involves the onsite peer assessment of conformity assessment bodies for their competence to carry out specified calibrations, tests, inspections and/or certifications of management systems, products, processes or personnel, to determine if they meet a required standard. These conformity assessment activities are critical to the quality and accuracy of the many products and services upon which all economies rely for, among other things, the health and safety of its citizens, and for trade.

B.2 Specialist Regional Bodies (SRBs)

The following five Specialist Regional Bodies are recognised by APEC.

B.2.1 ASIA PACIFIC LABORATORY ACCREDITATION COOPERATION (APLAC) www.aplac.org

APLAC is a cooperation of accreditation bodies in the Asia Pacific region that accredit laboratories, inspection bodies and reference material producers.

Accreditation bodies in 17 APEC economies are signatories to the APLAC Mutual Recognition Arrangement (MRA) for testing and calibration; 11 APEC economies are covered by the APLAC MRA for inspection, 9 for ISO 15189 (medical laboratories), and 4 for accreditation of reference material producers (RMPs).

APLAC is a recognised region of the International Laboratory Accreditation Cooperation (ILAC), and cooperates with other regional groups of accreditation bodies around the world.

B.2.2 PACIFIC ACCREDITATION COOPERATION (PAC) www.apec-pac.org

The Pacific Accreditation Cooperation (PAC) is an association of accreditation bodies and other interested parties from the Asia and Pacific regions.

PAC promotes the international acceptance of accreditations granted by its accreditation body members, based on the equivalence of their accreditation programme for management systems, product or personnel. Accreditation bodies in 17 APEC economies are signatories to the PAC Mutual Recognition Arrangement (MLA) for QMS, 12 economies are covered by the PAC MLA for EMS and 11 by the PAC MLA for Product.

PAC operates within the framework of the International Accreditation Forum (IAF) and in cooperation with other regional groups of accreditation bodies around the world.

B.2.3 ASIA PACIFIC LEGAL METROLOGY FORUM (APLMF) www.aplmf.org

The Asia-Pacific Legal Metrology Forum (APLMF) is a grouping of legal metrology authorities in the Asia-Pacific Economic Cooperation (APEC) economies and other economies on the Pacific Rim, whose objective is the development of legal metrology and the promotion of free and open trade in the region through the harmonisation and removal of technical or administrative barriers to trade in the field of legal metrology.

APLMF members collaborate to promote the coordination and integrity of legal metrology activities and services in order to achieve greater harmony of measurement and testing within the Asia-Pacific Region and build mutual confidence in legal metrology activities and services among Members.

B.2.4 ASIA-PACIFIC METROLOGY PROGRAMME (APMP) www.apmpweb.org

The Asia-Pacific Metrology Programme (APMP) is a collaboration of the region's peak measurement institutes, primarily aimed at improving regional measurement capabilities and developing international recognition of these capabilities. This therefore provides the basis for effective participation by APMP members in the Mutual Recognition Arrangement (MRA) of the International Committee for Weights and Measures (CIPM) and dissemination of these capabilities to the Asia Pacific user community.

B.2.5 PACIFIC AREA STANDARDS CONGRESS (PASC) www.pascnet.org

PASC is an independent organization of Pacific area national standards organizations. An important objective of PASC is to exchange information and views between national standards bodies and among organizations interested in standardization and conformance and initiate necessary actions to help ensure that international standardization activities are properly coordinated on a consensus basis to meet world needs and foster international trade and commerce.

Asia-Pacific
Economic Cooperation

APEC Sub Committee on Standards and Conformance
Education Guideline 3 – Textbook for Higher Education

Standardization : Fundamentals, Impact, and Business Strategy

Annex C.

Sample Standard - ISO/IEC 27000:2009

INTERNATIONAL STANDARD

ISO/IEC 27000

First edition
2009-05-01

Information technology — Security techniques — Information security management systems — Overview and vocabulary

Technologies de l'information — Techniques de sécurité — Systèmes de gestion de la sécurité des informations — Vue d'ensemble et vocabulaire

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0 Introduction

0.1 Overview

International Standards for management systems provide a model to follow in setting up and operating a management system. This model incorporates the features on which experts in the field have reached a consensus as being the international state of the art. ISO/IEC JTC 1 SC 27 maintains an expert committee dedicated to the development of international management systems standards for information security, otherwise known as the Information Security Management System (ISMS) family of standards.

Through the use of the ISMS family of standards, organizations can develop and implement a framework for managing the security of their information assets and prepare for an independent assessment of their ISMS applied to the protection of information, such as financial information, intellectual property, and employee details, or information entrusted to them by customers or third parties.

0.2 ISMS family of standards

The ISMS family of standards[1)] is intended to assist organizations of all types and sizes to implement and operate an ISMS. The ISMS family of standards consists of the following International Standards, under the general title *Information technology — Security techniques*:

— ISO/IEC 27000:2009, *Information security management systems — Overview and vocabulary*

— ISO/IEC 27001:2005, *Information security management systems — Requirements*

— ISO/IEC 27002:2005, *Code of practice for information security management*

— ISO/IEC 27003, *Information security management system implementation guidance*

— ISO/IEC 27004, *Information security management — Measurement*

— ISO/IEC 27005:2008, *Information security risk management*

— ISO/IEC 27006:2007, *Requirements for bodies providing audit and certification of information security management systems*

— ISO/IEC 27007, *Guidelines for information security management systems auditing*

— ISO/IEC 27011, *Information security management guidelines for telecommunications organizations based on ISO/IEC 27002*

NOTE The general title "*Information technology — Security techniques*" indicates that these standards were prepared by Joint Technical Committee ISO/IEC JTC 1, *Information technology*, Subcommittee SC 27, *IT Security techniques*.

International Standards not under the same general title that are also part of the ISMS family of standards are as follows:

— ISO 27799:2008, *Health informatics — Information security management in health using ISO/IEC 27002*

1) Standards identified throughout this subclause with no release year indicated are still under development.

0.3 Purpose of this International Standard

This International Standard provides an overview of information security management systems, which form the subject of the ISMS family of standards, and defines related terms.

NOTE Annex A provides clarification on how verbal forms are used to express requirements and/or guidance in the ISMS family of standards.

The ISMS family of standards includes standards that:

a) define requirements for an ISMS and for those certifying such systems;

b) provide direct support, detailed guidance and/or interpretation for the overall Plan-Do-Check-Act (PDCA) processes and requirements;

c) address sector-specific guidelines for ISMS; and

d) address conformity assessment for ISMS.

The terms and definitions provided in this International Standard:

— cover commonly used terms and definitions in the ISMS family of standards;

— will not cover all terms and definitions applied within the ISMS family of standards; and

— do not limit the ISMS family of standards in defining terms for own use.

Standards addressing only the implementation of controls, as opposed to addressing all controls, from ISO/IEC 27002 are excluded from the ISMS family of standards.

To reflect the changing status of the ISMS family of standards, this International Standard is expected to be continually updated on a more frequent basis than would normally be the case for other ISO/IEC standards.

Information technology — Security techniques — Information security management systems — Overview and vocabulary

1 Scope

This International Standard provides:

a) an overview of the ISMS family of standards;

b) an introduction to information security management systems (ISMS);

c) a brief description of the Plan-Do-Check-Act (PDCA) process; and

d) terms and definitions for use in the ISMS family of standards.

This International Standard is applicable to all types of organization (e.g. commercial enterprises, government agencies, non-profit organizations).

2 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

NOTE A term in a definition or note which is defined elsewhere in this clause is indicated by boldface followed by its entry number in parentheses. Such a boldface term can be replaced in the definition by its complete definition.

For example:

attack (2.4) is defined as "attempt to destroy, expose, alter, disable, steal or gain unauthorized access to or make unauthorized use of an **asset** (2.3)";

asset is defined as "anything that has value to the organization".

If the term "**asset**" is replaced by its definition:

attack then becomes "attempt to destroy, expose, alter, disable, steal or gain unauthorized access to or make unauthorized use of anything that has value to the organization".

2.1
access control
means to ensure that access to **assets** (2.3) is authorized and restricted based on business and security requirements

2.2
accountability
responsibility of an entity for its actions and decisions

2.3
asset
anything that has value to the organization

NOTE There are many types of assets, including:

a) **information** (2.18);

b) software, such as a computer program;

c) physical, such as computer;

d) services;

e) people, and their qualifications, skills, and experience; and

f) intangibles, such as reputation and image.

2.4
attack
attempt to destroy, expose, alter, disable, steal or gain unauthorized access to or make unauthorized use of an **asset** (2.3)

2.5
authentication
provision of assurance that a claimed characteristic of an entity is correct

2.6
authenticity
property that an entity is what it claims to be

2.7
availability
property of being accessible and usable upon demand by an authorized entity

2.8
business continuity
processes (2.31) and/or **procedures** (2.30) for ensuring continued business operations

2.9
confidentiality
property that information is not made available or disclosed to unauthorized individuals, entities, or **processes** (2.31)

2.10
control
means of managing **risk** (2.34), including **policies** (2.28), **procedures** (2.30), **guidelines** (2.16), practices or organizational structures, which can be administrative, technical, management, or legal in nature

NOTE Control is also used as a synonym for safeguard or countermeasure.

2.11
control objective
statement describing what is to be achieved as a result of implementing **controls** (2.10)

2.12
corrective action
action to eliminate the cause of a detected nonconformity or other undesirable situation

[ISO 9000:2005]

About
the Editors / Authors

About the Editors/Authors

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