

Anwar El-Tawil

Standards and Quality



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Anwar El-Tawil

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DEDICATION

This book is dedicated to the memory of Dr. Lawrence D. Eicher,
Secretary General of ISO from 1986 to 2002.

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PREFACE

It is well known that standards and quality are closely related. While many books and references have been written on quality techniques, much less was written about the techniques of standard setting and the institutions involved in that activity at the industry, national and international levels.

This book is about standards and quality. The book provides the essential features of both disciplines. It starts with an overview of standardization: what are standards, what benefits they bring, how they evolved. Then it goes on to describe the essential features and bodies active in national and international standardization. Conformity to standards is discussed, as well as accreditation and the bodies that carry out these activities.

Quality and quality management are described. A brief history of the evolution of quality concepts from preindustrial times till the present is given. Quality techniques are described including quality management systems according to ISO 9000 series of standards and the six sigma approach to quality management.

The books also includes an overview of other management systems such as food safety management, social responsibility and energy management. The role of metrology is described and the different elements of the quality infrastructure are explained.

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CHAPTER 1

STANDARDS AND THEIR BENEFITS

1.1 WHAT ARE STANDARDS?

In common language the word “standard” signifies several things and is used in many different contexts. The Oxford English Dictionary gives the following meanings of the word standard: 1) level of quality or attainment; 2) something used as a measure, norm or model in comparative evaluations; 3) a military or ceremonial flag; 4) a tree that grows on an erect stem of full height; 5) an upright water or gas pipe. The English word “standard” stems from an old French word that means a flag (cf. meaning no. 3 of the Oxford Dictionary above). This word indicates the position of a standard, which is that of a lead object that is followed by the troops of an army or by people in general.

In social sciences the word standard is used in the expression “standard of living”, in economics we encounter the “gold standard”, in animal husbandry the “breed standard”, in mathematics the “standard deviation” and in cryptology the “encryption standard”.

This and the following chapters deal with **documentary standards** applicable to production and service processes and to the outcome of those processes: products and services. Documentary standards are best described by the International Organization for Standardization (ISO) and the International Electro-technical Commission (IEC), the two apex international standards organizations. The definition of “standard” given by these two organizations is as follows^a:

^aThis definition is given in the publication authored by the two international organizations entitled « ISO/IEC Guide 2: 2004 Standardization and related activities -- General vocabulary »

A Standard: is a *document established by consensus and approved by a recognized body that provides for common and repeated use, rules, guidelines or characteristics of activities or their results aimed at achieving the optimum degree of order in a given context.*

Several important characteristics of documentary standards follow from this definition. First, it implies that standards are established by consensus, which means that those concerned by the standard, usually called the stakeholders, have agreed that a given standard is the best way of doing business and that it safeguards their interests in a balanced manner. Secondly, the definition mentions that standards are established for common and repeated use. This distinguishes a standard from an agreement between business partners that deals with one particular situation and may be fixed in a contract or in letters of acceptance but need not be fixed in a document available to other parties such as a standard. Thirdly, the definition describes the possible content of a standard as being rules, guidelines or characteristics that apply to activities or processes as well as to their outcome. Such an outcome could be a product or a service.

The definition also states that standards are established by a recognized body. This limits the establishment of formal standards to recognized bodies that are in a position to get the stakeholders of standardization together in a way that promotes the establishment of consensus. Such bodies provide a suitable forum for precise formulation, further development and updating of the standard. Those bodies facilitate the publication of standards, make them available to users and act as a repository for the collection of standards in the given field or fields. For a more detailed description of the status and functioning of standards bodies, see Chapter 3.

An important aspect of documentary standards as defined by ISO/IEC is expressed in the last phrase of the definition, which states that a standard *aims at achieving the optimum degree of order in a given context.*

Obviously, standardization is about putting order in a given situation. Better order is ensured by specifying characteristics of the product or service. Order is also improved by limiting variety, since unlimited variety may lead to an unacceptable increase in the cost of the product or service not matched by an increase in the degree of satisfaction of the user. Searching for the optimum degree of order is one of the prime tasks of standardization. Those engaged in standardization are constantly looking for the best possible compromise between two extremes: on one hand, an excessive variety that leads to an increase in cost not matched by a worthwhile improvement of the product or service and, on the other hand, a severe limitation of variety which may lead to a reduction of satisfaction of the customer or user of the product or service. A good example of the *optimum degree of order* is evident in the case of sizes of clothes and shoes. Too many finely spaced sizes would lead to a great increase in cost as the advantages of mass production are lost and stocking and distribution become more difficult. On the other hand, too coarse a gradation of sizes would mean badly fitting clothes and uncomfortable shoes!

1.2 THE BENEFITS OF STANDARDS

Standards have numerous benefits and this fact explains their widespread application in most areas of human activity. Standards are especially important to ensure product safety and minimum quality, to facilitate compatibility between product components and between products, to optimize variety and to facilitate communication and the provision of information about products, services and situations.

1.2.1 Standards ensure product safety and minimum quality

Most products can be a source of hazard to the health and safety of people, if not properly made and packed or if not properly stored and used. Examples of such products are food products, toys, electric and gas appliances. Standards play an important role in ensuring the safety of such products by requiring that mandatory safety measures be incorporated into the products, not allowing sources of risk and

specifying adequate packaging, storage and use instructions to be provided to the users.

Standards for fire-prevention and fire-fighting equipment play an equally important role in protecting people and property against fire hazard. A fire extinguisher in a building or in a car manufactured and maintained according to standards gives assurance that it will perform adequately and will not fail in the critical moment of a fire breaking out. Equally important is the written and/or graphical information on how to use the extinguisher, which should be provided in a clear, easily understandable manner.

For all products, whether hazardous or not, standards provide an important benefit as they guarantee a minimum level of quality. Standards for products and services often specify minimum use and efficiency characteristics which, if absent in the product or service, would lead to a waste of resources rather than a tangible benefit for the user. For example, if a product or appliance does not give good and efficient performance or breaks down after a very short time, this would mean a waste of consumer money and of natural resources.

1.2.2 Standards facilitate market entry and promote competition

The existence of standards facilitates the job of new producers of goods and providers of services who wish to enter the market. By consulting existing standards, those potential producers and service providers can get a reasonable idea of which characteristics should be present in the products and services they intend to offer. This allows smooth planning of production or service provision and good chances of acceptance of the resulting product or service in the intended markets. Easier market entry promotes competition as new producers can relatively easily start production or service provision. This promotes the interests of consumers since competition and the avoidance of monopoly situations help improve quality and reduce prices.

1.2.3 Standards are essential for trade facilitation

Standards are extremely useful for trade facilitation. The existence of standards makes it much easier to set-up clear contracts: rather than trying to specify in the contract the detailed characteristics of the contracted product or commodity, it is sufficient to refer to an existing standard. Not only would this save pages and pages of specifications, it would also save the possible haggling over the actual specifications themselves! In addition, the reference to a standard would reduce to a minimum possible litigation at the time of delivery: standards not only specify important characteristics of the product or service, they also specify how to sample and test the product and how to interpret test results.

1.2.4 Standard are necessary to ensure compatibility

The modern world provides numerous advantages to people many of which are based on compatibility. Compatibility exists on two levels: a) between parts and components of a product and b) between products.

When a part of a complex machine such as a car or a plane is broken or wears off, it is possible to replace it with an equivalent “spare” part produced by the same producer or by another producer on the other side of the globe, which then performs the same functions as the original part. This simple act is so commonplace in today’s world that people take it for granted and are mostly unaware of the sophisticated standardization and engineering effort behind it. The “**interchangeability**” of parts and components, as this is called, is based on standardization of fitting sizes of the parts as well as their other properties such as strength, hardness, electrical properties (in the case of electric components), resistance to rust and chemicals and others. The advantages of the interchangeability of parts and components are too obvious to be enumerated. Suffice it to say that, in the absence of interchangeability, every bolt and screw would fit only into a specially made nut or screwed hole^b; sophisticated machines would be extremely vulnerable to breakdown, as failure of

^bThree of the first international standards published by the International Organization for Standardization – ISO 7-1, ISO 7-2 & ISO 68 deal with screw threads

their weakest component would lead to a breakdown and loss of value of the whole machine or would make repair extremely costly.

Compatibility between different appliances and machines makes it possible to use together different devices having different functions. For example, a digital camera using a memory card can be connected to a computer; pictures can be transferred from it to the computer for editing, storage, posting and e-mailing; the pictures can be projected on a screen using a projector or printed using a printer. In this case, “**interoperability**” of the camera, the memory card, the computer, the e-mail system, the projector, the TV and the printer is made possible by standardization of the inputs and outputs of each of these devices as well as the connections between them. The Universal Serial Bus (or USB as it is commonly known) is a marvelous example of a standardized device that enables the connection of different information technology appliances. Other examples of interoperability abound not only in information and communication technologies but in transport, construction and other fields as well.

1.2.5 Standards improve economy by reducing unnecessary variety

Variety is a costly good. Consumers and users who wish to receive products and services that fit exactly their individual needs are quite aware of this fact. As individual needs vary with the individuals themselves, an infinite variety would be needed to completely fulfill the desire to have products and services that fit exactly each individual need. This would mean individual production and/or fitting of each product and service to the needs of the particular customer. In the majority of cases, this implies a great increase in cost, as the advantages of high volume or mass production can no longer be realized. Standards help solve this problem by pointing to an optimum variety that would satisfy needs to a reasonable degree without raising the cost of the product or service to a level prohibitive for most consumers.

The theoretical basis for an optimum choice of variety was laid by Colonel Charles Renard of the French Army in the 19th century. “Preferred numbers”, proposed by Renard allow an optimum choice of variety in a particular situation. Renard’s preferred numbers incorporated in the International Standard ISO 3 published by the International Organization for Standardization in 1952 offer a choice of variety from a coarse gradation (low variety) to an increasingly finer gradation (high variety).

1.2.6 Standardization of graphical symbols and colors facilitates communication in all fields

International travelers appreciate the value of standardized symbols and colors which allow them, irrespective of the language or the country where they happen to be, to use cars safely without infringing traffic rules, use public transport, find their way in buildings, airports and stations (in particular, find exits, find toilets and use elevators), use equipment, find what they are looking for in health care establishments, be warned about dangers and do a host of other things. This is made possible thanks to agreements incorporated in international standards such as the ISO 7000 series — Graphical Symbols. The use of standardized graphical symbols continues to grow and this has salutary effects on communication in the fields of traffic, sports, science and many others.

1.3 THE EVOLUTION OF STANDARDIZATION

Standardization is not a new activity: it has existed in societies since the dawn of civilization. Ancient civilizations standardized weights and measures and this facilitated the replacement of barter by a monetary economy. The ancient written languages such as ancient Egyptian hieroglyphics and the Chinese script were a manifestation of the standardization of graphical symbols to convey given meanings. Ancient civilizations also standardized the calendar, which in its primitive form consisted of 12 months of 30 days each, then was corrected to include

five “forgotten days” and subsequently corrected again to include the leap year and its modifications that coincide with the solar year in a more faithful manner.

Ancient civilizations applied standardization to building construction. This made possible the marvelous construction projects that mark the great civilizations of the past. In ancient Egypt, the great pyramid of Khufu was built over 20 years (around 2560 BCE) of an estimated 2,300,000 stones of standard size. In China, the Great Wall built by Emperor Qin Shi Huang starting 221 BCE followed a standardized pattern over its length of 10,000 Li (1 Li is equal to 500 meters). With 25,000 standardized watchtowers, the Great Wall of China is a good example of standardization applied to great construction works of ancient times.

Centuries after these amazing manifestations of standardization in ancient times, standards took on new dimensions with the industrial revolution. The use of new types of power such as steam and electric power exposed workers and the public to new hazards.^c As accidents multiplied, many of them fatal, the industrializing countries responded by establishing standards for the safety of pressure vessels, gas and electric machines. The industrial revolution also saw the development of mass production and the introduction of interchangeability of parts of complex machines. This made necessary the establishment of standards to facilitate the production and supply of spare parts.

Later, standards were established to facilitate inter-operability of machines and devices. In 1904, a great fire broke out in Baltimore. When firefighters rushed from far to the city to extinguish the fire, they found that their hose couplings could not be attached to the hydrants or to other

^cIn 1884 alone approximately 10,000 boiler explosions and failures occurred in the US. In 1865, three of the four boilers of the Sultana, a Mississippi side-wheeler, exploded. The vessel burned to the waterline with a death toll estimated between 1200 and 1500. This is the US worst marine disaster in history.

hoses. This prompted the standardization of hose couplings by the US National Fire Protection Association.

Pipe sizes and sanitary fittings were standardized to facilitate the construction of plumbing systems in homes. The development of the automobile industry based on the assembly of parts and components produced by many small producers gave a strong impetus to standardization in mechanical engineering. In electrical engineering, plugs and sockets were standardized and so were lamps and their fittings as well as voltages and frequencies utilized in electricity production and distribution. In building construction, modularly coordinated spaces are built with standard bricks and blocks. In information technology, standardization had a dominant role from the start, which enabled the interoperability of devices and facilitated the interconnection of individual computers into a worldwide network — the Internet. The era of standardized products, services, buildings, information and communication was started and is still in full swing.

1.4 SHOULD STANDARDS BE MADE MANDATORY?

A question often debated by those concerned by standards is whether standards should be made mandatory in view of the many benefits they provide to society. The answer to this question in centrally planned economies (for example, the ex-Soviet Union and its satellites) was in the affirmative. It was argued that it is in the interest of society to make all standards mandatory and, indeed, standards were used in conjunction with quantitative planning to evaluate the performance of economic units such as factories and collective farms. This approach provided a substitute for the evaluation of the success or failure of enterprises in a situation where the traditional market indicators profit and loss played a much lesser role than in a free market economy.

In advanced market economies, however, the general attitude is that, while some standards should be made mandatory to safeguard the health and safety of people and the environment, the majority of standards should remain voluntary. The reasoning behind this attitude is that

mandatory standards for all products and services would put unnecessary constraints on innovation and that market forces are sufficient to guide producers and service providers to produce products and offer services that satisfy the needs of consumers. Indeed, those innovative entrepreneurs who wish to propose a new design for existing products or a new line of products find it easier to act, where there are no mandatory standards that oblige them to follow a particular solution.

To avoid confusion in terminology, the Agreement on Technical Barriers to Trade of the World Trade Organization uses the term “standard” to designate voluntary standards and the term “technical regulation” to designate mandatory technical rules. Technical regulations can be based on existing voluntary standards that have been transformed into mandatory regulations or can be established independently. In market economies, it is customary to reserve the establishment of mandatory technical regulations to the cases where the health and safety of people and the protection of the environment are involved. For a more detailed discussion of the relationship between voluntary standards and mandatory technical regulations, see Chapter 6 – Standards and Trade.

1.5 SHOULD THERE BE STANDARDS IN ALL AREAS OF HUMAN ACTIVITY?

In literature and the creative arts the words “standard” and “standardization”, have negative connotations. Standardization with its stabilizing effects could be an obstacle to innovation, which is the essence of creativity. Consequently, in spite of the advantages of standardization in the technical and economic fields, standards are not promoted in the creative arts except where they are necessary as part of the material basis of those arts.

Examples of standards related to the material basis for the fine arts are the standard frequencies of musical notes (although non-standard frequencies also have their place in modern music), the standards for

paints, colors and painting supports in painting and the standards of sizes of paper and books and for typing fonts in literature.

Standards are needed and should be used to provide a reliable and permanent material basis for the arts. However, free creativity as the essence of art should not be hampered by standards. Writers, poets, musicians and artists are expected to go beyond the known and the common in search of novel and enriching experiences for the human mind.

CHAPTER 2

THE STANDARDIZATION PROCESS

2.1 ESTABLISHING NATIONAL STANDARDS

Standards can be established at different levels: company, industry, national, regional or international. This Chapter deals with the process of establishing, promoting and maintaining national standards. Establishing regional and international standards is dealt with in Chapter 4.

The process of establishing and maintaining national standards usually includes the following stages:

- a) Establishing the Standards Development Plan, often referred to as the Work Programme of the national standards body
- b) Developing the standards
- c) Approving the standards
- d) Publishing the standards
- e) Promoting the standards to potential users
- f) Maintaining the standards

Some of these stages may overlap. For example, a future standard may be promoted before it is finally approved and published. Maintaining standards is a continuous process that involves standards that have been already published.

2.2 THE STANDARDS DEVELOPMENT PLAN OR WORK PROGRAMME

Most national standards bodies go about establishing national standards according to a previously set plan. Some of these bodies establish a yearly plan while others set a plan encompassing several years.

The following factors should be considered when setting the standards development plan:

- a) The important sectors of the national economy. The importance of economic sectors can be judged by their contribution to the Gross Domestic Product (GDP) of the country as well as by their contribution to foreign trade and export. For many countries, exporting commodities and products has special importance, since it is the main source of foreign currencies, which can be used to finance the vital needs of the population.
- b) The social needs of the population, such as the need to protect the health and safety of people and their welfare in general and the need to protect the environment. These needs become evident, for example, as accidents due to faulty products happen and result in loss of life or property or damage to the environment. Typical standards meant to protect health, safety and the environment are those for fire prevention and firefighting, food products, electric and gas appliances, pressure vessels, standards dealing with dangerous chemicals and ionizing radiation and those dealing with the transport of dangerous goods.
- c) The specific needs of stakeholders of standardization in the country, who should be regularly asked to provide their standardization needs to the national standards body.
- d) If the country belongs to a regional economic group, attention should be given to existing regional standards and to plans for setting such standards.
- e) The resources available to the national standard body to carry out standardization work.

Investigation of the above factors may yield results at different levels. Some studies may point out to the need to give special attention to setting standards for particular economic sectors (such as the textile industry) or particular export products (such as cotton yarn). Other investigations may highlight particular subjects for standardization (such as the safety of domestic gas appliances). Combining the different types of results to obtain an optimum yearly or multi-yearly standards

development plan is a complicated task facing all national standards bodies.

The International Organization for Standardization (ISO) has developed a methodology for setting national standardization strategies for the benefit of its members. This methodology proposes the use of a weighting system for combining the different estimated priorities into a single priority for each proposed subject for standardization (or work item), resulting in a multi-yearly standards development plan based on priorities and available resources.

Details of the ISO methodology are available on the Organization's website at www.iso.org.

2.3 DEVELOPING AND APPROVING STANDARDS

Once the Work Program of the national standards body has been approved, the standards development process can be started. This process consists of a number of stages.

First, there is a ***preparatory stage*** carried out usually by the staff of the national standards body. Standards engineers (as this staff will be called in the following) search for references for the future standards. References may be international standards or drafts, regional standards or drafts where they exist, national standards of other countries or other documents. The search should be carried out in this order for the following reasons.

International standards should be given priority in application of the Technical Barriers to Trade (TBT) Agreement of the World Trade Organization. This Agreement, which is mandatory for all WTO members, mandates the “use of international standards or parts of them where they exist or their completion is imminent, as a basis for national standards, except where they are ineffective or inappropriate, for instance, because of an insufficient level of protection or fundamental

geographic factors or technological problems”.^d The logic for this requirement of the TBT Agreement is obvious: if all countries adopt international standards as a basis for their national standards, technical barriers to trade between countries due to differing standards would be eliminated and international trade would be greatly facilitated.

Countries that are members of regional groups are interested in aligning their standards with regional standards. For example, members of the European Union are interested in adopting European standards as national standards since this is necessary to facilitate their trade with other members of the EU. So that the second priority after international standards should be to use regional standards, if the country belongs to a regional economic group, as a reference for national standards. Countries that do not belong to a regional group but have important trade links with a particular regional group might also wish to align their national standards to the regional standards of that group.

Where no international or regional standards exist, references for national standards could be sought in the national standards of foreign countries that have strong trade relations with the country concerned. Care should be exercised at this stage not to isolate the country for a long time by aligning its standards to standards which are deemed outdated or having no future. Finally, references for national standards should be sought in standards or rules applied by important local industries.

The next stage in standards development is establishing the technical committees (TCs) that will study the subjects at hand and provide their technical opinion. It might seem that, where it was decided to adopt an international or a regional standard, there is no need to establish a technical committee. However, there is still an important role to be played by the technical committee. The committee should study the content of the international standard to see if it is possible and desirable to implement it under local conditions.

^dAnnex 3 to the Agreement on Technical Barriers to Trade, ...

Technical committees should be established in such a way that they include a balanced representation of national stakeholders and include the best expertise available in the country in the area concerned. Stakeholders include manufacturers, users (including consumers), traders (including local traders, importers and exporters), test laboratories, certification bodies and technical experts. The presence of representatives of the different stakeholders, who may have conflicting interests, is the guarantee that the developed standards would be based on true consensus achieved at the national level. Since a high level of expertise is needed for standards development, the technical committee should include experts some of whom will be representatives of manufacturers and users of the product, while others should come from universities, scientific research institutes, and test and certification bodies.

Each of the above groups of stakeholders have their particular interests and characteristics that require a special approach to each group. Manufacturers usually have the financial and technical means to participate effectively in standards development. The limitation in their case is that only a limited number of them can be invited to send representatives to the technical committees, so that they would not dominate the discussion. While this might be the important issue concerning large manufacturing companies, small and medium sized enterprises (SMEs) have the opposite problem: they are interested in participating in standards developing committees, but may not always have the financial means and the expertise required for participation. They should be assisted in presenting their point of view, for example, by inviting a collective representative of their trade associations.

Another group of stakeholders that needs support to be able to present their point of view concerning standards is consumers. They are the most numerous group but also the technically weakest. One way of assuring good representation of consumers is for the national standards body to

appoint a technical expert charged with liaising with consumer associations and representing them at the committee meetings.

In order to effectively follow-up international standardization work and to align national standardization to it, it is recommended to establish national committees in parallel to existing international technical committees. Such national technical committees are known as “mirror committees”. If a one-to-one relationship between national and international committees cannot be established due to lack of resources or any other reason, each national technical committee should be “allocated” one or more international technical committees whose work it should follow-up.

The two most important players in the technical committee (TC) are the chairperson and the technical secretary. The chairperson should preferably be an eminent expert and neutral. University professors and research workers could easily fulfil these two conditions. The chairperson should have a good knowledge of the subjects dealt with by the technical committee and additionally possess the ability to lead the members to an agreement. An important quality required of the chairperson is that s/he is able to devote enough time to the work of the technical committee.

Work in the technical committee: During committee meetings, the chairperson should lead but not dominate discussions. S/he should tactfully stop useless discussions and talkative members. The chairperson should be capable of representing the technical committee, if necessary, inside the country and abroad. S/he should establish a fruitful relationship with the secretary of the TC.

The technical secretary of the committee is the representative of the national standards body (NSB). Consequently, s/he is the host of the TC and should be capable of representing the NSB in an adequate manner. The technical Secretary should have an excellent knowledge of the

procedures for technical work of the NSB, since s/he is responsible for their application.

The Secretary prepares the meetings of the TC in consultation with the chairperson. This includes fixing the dates of the meetings, preparing the draft agenda and the meeting reports, circulating to TC members the draft report of the last meeting, the texts of the drafts under consideration, references such as international and regional standards. The secretary should compile the comments received on the drafts in such a way as to facilitate decision making during the meeting.

The TC secretary is also responsible for the follow-up of international drafts, presenting them to the TC and obtaining decisions on how the country should vote. The TC secretary is responsible for managing the development of each national standard as a project by setting target dates for the main stages, identifying problems and proposing solutions. After a draft standard has been approved, the secretary follows up its publication.

The TC secretary should have a suitable technical background to be able to understand the content of the standards for which s/he is responsible. However, the TC secretary is not expected to be an expert in all the fields s/he has to deal with. The secretary should have the capacity of good organization, be courteous and hospitable towards the committee members.

Where a technical committee has a broad field of activity, it can be subdivided into sub-committees (SCs) each with its own chairperson. The same secretary could serve the main committee and the subcommittees, or s/he could have other standards engineers to help. Technical committees and sub-committees could establish working groups with a limited number of experts to study and propose a draft standard or a set of related draft standards. These drafts should

subsequently be submitted to the main TC or SC for discussion and approval.

Achieving consensus on technical questions is not always easy. The Chairperson and the Secretary should, therefore, discuss thorny issues together *before the meeting to try to prepare solutions*. It is useful in this concern to classify the points of disagreement by importance, to start by considering the major points and to think about the reasons behind the position of the different parties. It is equally important to separate technical issues from purely editorial ones.

Where consensus cannot be reached on a whole question, dividing it into parts and discussing each part separately might help. Choosing the solutions proposed by international standards should always be preferred, since they represent global consensus and reflect the contemporary state of the art. In case consensus cannot be reached during a committee meeting, the chairperson should propose the postponement of the discussion and/or the creation of an ad hoc group to study the matter. If all efforts to achieve consensus fail because of a small objecting minority, it might be necessary to adopt the solution supported by a solid majority of the members of the committee. Voting is not the optimum way to achieve consensus, but in some cases, it might be the only way out. The minority group may request that their objection and their point of view be recorded in the committee report and this wish should, of course, be granted. Obviously, consensus should not be established at the expense of the quality or the technical coherence of the standard.

Agreement reached on main issues should always be recorded in the report of the TC meeting under “Resolutions”. In this way, the committee avoids reopening the debate in the following meetings, which could lead to interminable discussions. The meeting report should be short and concise, unless there is a good reason to the contrary.

Approval of draft standards: Drafts prepared by technical committees undergo a further process of approval. First, they are circulated for

comments to all possible national stakeholders. Many national standards bodies post draft standards on their Websites. However, it is always desirable to inform stakeholders (for example, by a circular e-mail) that a new draft has been posted, so that interested parties could view and comment on it. After a suitable period, the comments are collated and presented to the technical committee. Comments may be of an editorial or substantive nature. Both should be considered and dealt with appropriately. A new draft may be circulated, if the substantive comments are important. The process is repeated until consensus^e is reached. Some national standards bodies leave the decision as to whether consensus reached is satisfactory to the technical committee. Others require approval by a higher instance, which could be a sectorial board or it could be the Management Board of the institution where the different groups of stakeholders are represented. With the increasing number of standards being developed at present, this latter practice (approval by the Management Board of each standard) has become very rare and it is, indeed, not recommended.

It is important that the national standards body establish and follow well-defined procedures for the standards development process. Such procedures should define the rules for each stage of the process, the roles and responsibilities of the different players. The standards development procedures should be clear and unambiguous, so that they can be followed easily and can provide a basis for arbitration where differences appear.

2.4 PROMOTION OF THE USE OF PUBLISHED STANDARDS

The promotion of the use of published standards is a necessary activity that should be carried out by national standards bodies. Where the process of standard development was carried out properly, a large number of stakeholders would already be aware of the existence of the standard. However, many more individuals at the stakeholder level

^eISO and the IEC define consensus as « general agreement, characterized by the absence of sustained opposition by any part of the concerned interests and by a process that involves seeking to take into account the views of all parties concerned and to reconcile any conflicting arguments. » “NOTE — Consensus need not imply unanimity”

would still not be aware that the standard has been published and/or would not know its exact content in its final form.

Publicizing the use of national standards is of interest to the national standards body, since the sale of standards is in most countries an important source of revenue for the NSB. Even in countries where the NSB is generously financed by the Government, it would be a waste of public money that the standards go unnoticed by stakeholders who would individually and collectively benefit from their implementation. It should not be forgotten that coherent standards are useful not only to those who implement them directly, but also to individuals and entities that have activities related to the field of the standard. For example, standards for the sizes of paper would affect not only the paper industries, but they would also affect the publishing industries, individual users of paper and generally reduce the waste of paper, which would in turn reduce deforestation pressures.

The promotion of the use of standards begins by providing the basic information on published standards. Such information includes the title, the year of publication, the number of the standard, international or regional references on which the standard is based and a short abstract. Providing information on standards is discussed in more detail in Chapter 4.

The promotion of published standards is also a promotion of the national standards body that published them. The higher the reputation of that body, the stronger the readiness of stakeholders to contribute to the development of new standards. This is in fact a self-reinforcing process: a reputed standards body gets good contribution to its work from stakeholders, who are, in turn, more apt to implement the published standard and more ready to contribute to the development of new standards.

2.5 MAINTAINING STANDARDS

Standards like all media of technical knowledge evolve with time. As new technological processes are developed and older ones are abandoned, standards reflect the current state of scientific and technical

knowledge and practice. A good example is standards for electronic components which started by standards for vacuum tubes, which were followed by standards for semiconductor discrete components (such as diodes and triodes) and, finally, by standards for integrated circuits.

National standards bodies have policies to review and revise where necessary the standards they have published. A period is set after which standards are automatically resubmitted to the technical committee that prepared them for review. The result of this review can be to confirm, revise or withdraw the standard. This does not prevent the committee deciding to start the revision of a particular standard, when it is clear that new information and practice justify such a revision.

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CHAPTER 3

THE NATIONAL STANDARDS BODY

3.1 WHY A NATIONAL STANDARDS BODY?

It is generally accepted that standardization is a necessary activity in all civilized societies. Standardization at the national level often starts by professional societies setting standards they feel are necessary for regulating practice in the areas of their activity. In the United Kingdom, for example, the first standard was developed in 1901 by the *Engineering Standards Committee*, established by the Institution of Civil Engineers.

As the demand for national standards increases, the establishment of a national standards body becomes a necessity. Taking again the example of the UK, in 1929, the Engineering Standards Committee was granted a Royal Charter and in 1931, a supplemental Charter was granted changing the name, finally, to the British Standards Institution.

The national standards body plays a vital role in promoting and coordinating standardization activities in the country and in ensuring that they are carried out according to internationally accepted rules. This body also plays a vital role in associating national standardization with standardization at the regional and international levels, which is extremely important for developing trade with other countries.

In most countries the national standards body plays an important role in the assessment of the conformity of products and services to standards. The national standards body is often the pioneer in conformity assessment. Their activity in the field of conformity assessment of

products, services and management systems often opens the way for private sector conformity assessment organizations.

3.2 CHARACTERISTICS OF THE NATIONAL STANDARDS BODY

The national standards body (NSB) should be a national technical body characterized by professionalism and integrity. The NSB should represent the interests of all stakeholders in a balanced manner, striving to serve the national interests without bias towards one stakeholder or group of stakeholders to the detriment of others.

Since both the Government and the private sector benefit from the activities of the NSB, they should both share in managing and financing the NSB. The NSB in a market economy should not be a technical regulatory body. The issue of mandatory technical regulations should remain in the domain of Government ministries and departments, although they will often use voluntary standards as a basis for mandatory technical regulations.

3.3 NATIONAL STANDARDIZATION POLICY

Most national standards bodies establish a *national standardization policy*. This is a document that provides principles for the standardization activity and helps guide actions in this field. The national standardization policy should be discussed by interested parties before it is approved. After its approval, the national standardization policy should be promoted widely to interested parties and to the public at large, to whom the broad outlines should be known.

The national standardization policy should clearly proclaim the following basic principles:

- National standards are based on consensus.
- The voluntary nature of national standards.

- Clear distinction between voluntary standards and mandatory technical regulations
- Commitment to adhere to the “Code of Good Practice for Standardization” of the Technical Barriers to Trade Agreement (TBT Agreement) of the World Trade Organization (WTO)
- Commitment to align national standards to international standards as far as possible

The national standardization policy could be published under this title or it could be part of the *vision and mission* of the national standards body.

3.4 STANDARDIZATION LAW

In most countries a law or similar legal instrument is issued that governs standardization activities. The standardization law usually gives the right to develop and publish national standards exclusively to the national standards body. Other organizations in the country may develop and publish standards that would not, however, have the status of national standards. The standardization law also gives the national standards body the authority to represent the country with regional and international organizations in the fields of standardization. The law may also specify certain aspects of governance, financing and controls of the national standards body.

The standardization law could also state some basic principles that apply to the elaboration and publication of standards, such as:

- The balanced representation of interested parties at the different levels of the national standards setting activity
- The wide consultation of parties interested in each standard
- The achievement of consensus as the basis for standards setting
- The voluntary nature of standards
- The desirability of harmonizing national standards with international standards as far as possible

3.5 GOVERNANCE OF THE NATIONAL STANDARDS BODY (NSB)

The highest governing instance of the national standards body, whether it is called the Governing Council, the Board of Directors or any other name should have a balanced representation of interested parties of standardization in the country.

The functions of the Governing Council of the NSB normally include:

- Establishing the policy of the NSB
- Approving the technical and administrative working procedures
- Approving the standards development plan
- Approving the establishment of technical committees and nominating their chairpersons
- Following up the implementation of the standards development plan
- Deciding the membership of the NSB in international and regional organizations in its fields of activity, such as standardization and conformity assessment
- Approving the budget and supervising the finances of the NSB
- Proposing the candidate to become the chief executive officer of the NSB and the candidates to become important directors in the organization

Where the NSB is engaged in other activities such as conformity assessment and certification, the Council would have planning and supervisory powers over those activities as well.

The governing council of the NSB may establish advisory bodies to assist it, for example:

- A Standards Development Advisory Committee and Sectorial Standards Committees
- A Conformity Assessment Committee

The chief Executive Officer (CEO) of the NSB and his staff are responsible for implementing the policies and procedures approved by the Council.

The governing council **should not** approve individual standards or be involved in the routine operations of the NSB.

3.6 DIRECTIVES FOR TECHNICAL WORK

The NSB should establish directives or procedures for carrying out the technical work. These directives should regulate aspects such as:

- Planning the development of standards and the establishment of the Work Programme of the NSB
- Establishing technical committees, sub-committees and working groups
- Nomination of chairs of technical committees and sub-committees and conveners of working groups
- The methodology of work in the technical committees, sub-committees and working groups
- Circulation of drafts and consideration of comments
- Definition and achievement of consensus
- Format of national standards
- Conditions and instances responsible for the approval of standards
- Appeals against decisions of technical committees and governing bodies of the NSB

3.7 FINANCING NATIONAL STANDARDIZATION

The largest part of the resources devoted to standardization comes from the stakeholders who serve as technical committee members as well as those who study and contribute comments to draft standards. Nevertheless, the NSB needs financing for the human and logistic support it provides to standards development and standards information, two activities that may not be financially self-sustainable.

Financing may be assured through various sources such as the sale of publications, training and information, members' subscriptions and Government support. Where the NSB is active in testing and certification, part of the revenue of these activities may be diverted to standards development, considering that it is the necessary basis of testing and certification.

In most developing countries, the NSB is a governmental body. Nevertheless, it is desirable to develop other sources of revenue since these would allow flexibility in covering expenses, permit reinvestment in the system and make the NSB generally more dynamic and market oriented.

In the establishment phase of a national standards body in developing countries, the Government should provide the initial investment to kick-start the NSB.

3.8 HUMAN RESOURCES OF THE NSB

The NSB needs to employ staff with a technical and scientific background to be able to understand standardization issues. Graduates with a university degree in engineering or science can be recruited. However, since very few universities offer undergraduate courses in standardization, the newly recruited staff should undergo some training oriented specifically toward the principles and practices of standardization.

Subjects for training of newly recruited staff members of the NSB should include:

- The history of standardization
- The components of the national quality infrastructure: standards, testing, certification, accreditation and metrology
- Principles of modern standardization

- The process of standards development
- Standards information
- Standards and trade — technical barriers to trade
- Notions of conformity assessment
- Notions of management systems
- Notions of metrology
- Language training for members who do not already have good language capabilities

Several resources may be available for training the staff of the NSB in developing countries. Examples of those are:

- Study tours with well-established NSBs abroad
- Local training using national and foreign resources (such as those provided by technical assistance agencies of foreign countries and by international organizations)
- Self-study using material of the International Organization for Standardization (ISO)
- ISO e-learning courses
- Seminars organized by the International Organization for Standardization (ISO) and other international organizations

CHAPTER 4

INTERNATIONAL STANDARDIZATION

4.1 A BRIEF HISTORY OF INTERNATIONAL STANDARDIZATION

The great empires of ancient times were, probably, the first place where the standards of one country were used in other countries under its domination. For example, under the Roman Empire, it was natural that roman currency, weights, measures and standards were used in all the countries under roman rule. The same happened during the zenith of the Spanish empire in Latin America and that of the French and British empires in their colonial dominions. This phenomenon often took place without special coercion, simply thanks to the economic and cultural influence of the dominant country. Standards in important fields such as building construction and electricity were also often copied from the dominant power, thanks to the economic influence of that power and since those standards were considered superior to the ones that existed locally before colonization.

The first attempt to propose truly international standards based on universal concepts was made when the French National Assembly, soon after the French Revolution of 1789, requested the French Academy of Science to “deduce an invariable standard for all measures and all weights”. The result of this request was the establishment of the Metric System of Units, in whose conception eminent scientists of the time (including the father of modern chemistry, Antoine-Laurent Lavoisier) participated. The Metric System was internationally accepted by the countries that signed the Metre Convention in 1875, and later evolved to

become the International System of Units SI (short for the French *Système International d'Unités*).

In the area of product standards, great progress was made when the principle of interchangeability was introduced both in Great Britain and in the USA in the beginning of the 19th century. Standardization of parts assembled into a larger object was known in antiquity (for example, in Egypt and China). It was also applied in shipbuilding in Venice, where a whole galley could be assembled on a production-line basis from standard parts, a method that enabled the Venetian Arsenale to produce one galley a day in the early sixteenth century. However, the application of that principle in mechanical engineering started much later when British arms manufacturers were able through standardization to provide spare parts for muskets sold in faraway Australia. In the USA, a great inventor, Eli Whitney, who had invented the cotton gin, proposed, “to substitute correct and effective operation of machinery for the skill of the artisan”. By this, he meant to replace the individual fitting of parts of a musket by the assembly of standardized parts manufactured with sufficient accuracy so that they could be fitted together without rework. In a historically famous demonstration, Whitney demonstrated in 1801 to the President and Vice President of the USA at that time the principle of interchangeability in the assembly of muskets from parts chosen at random from a number of boxes. Another important step forward was made by Joseph Whitworth, the British engineer who proposed in 1841 a standardized thread that ended the conundrum of non-standard screws, bolts and nuts, which did not fit each other and had to be manufactured specially for each usage.

The first international organization with an important standardization activity was the International Telecommunications Union (ITU) established in 1865. This is not surprising, since the field of communications is one where harmonized standards are a prerequisite for achieving communication. The next area where international standardization was desperately needed was that of the production and distribution of electric energy. For electric energy to be distributed and used by industries and households, certain parameters needed to be standardized such as the voltage and frequency of alternating current.

This led to the establishment in 1906 of the International Electro-technical Commission (IEC).

After a number of national standards bodies were established, international standardization in fields other than electrical technology was proposed. By 1926, some 15 NSBs existed in industrialized countries. The Secretary General of the IEC led a movement supported by American and European NSBs to establish an international organization for standardization in fields other than electrical technology.

The International Standards Association (ISA) was established in 1926 and was adhered to by 15 NSBs from Europe, Japan and the USA. ISA started to develop international standards, which included standards for preferred numbers and for a system of fits and tolerances. After a period of intense activity during the 1930, ISA stopped its activity when World War II started.

After the end of the war, new initiatives appeared to restart international cooperation in standards development. In 1946 at a Conference held in London it was decided to establish a new international standards organization as a non-governmental confederation of the national standards bodies of all countries. The International Organization for Standardization (ISO) started its activities in the beginning of 1947.

Two other international organizations were later established as intergovernmental standards organizations. These are the International Organization of Legal Metrology (OIML) established in 1955 as an association of national legal metrology bodies, and the Codex Alimentarius Commission (CAC), which was established in 1963 by two UN agencies: the Food and Agriculture Organization (FAO) and the World Health Organization (WHO).

4.2 THE INTERNATIONAL ORGANIZATION FOR STANDARDIZATION (ISO)

In 1946, 65 delegates from 25 countries met in London to discuss the future of international standardization. In 1947, the International



Figure 1 – Founders of ISO, London 1946

Organization for Standardization (ISO) officially came into existence with 67 technical committees. An increasing number of members including many developing countries quickly joined ISO. Those countries were at that time starting the process of industrial development and had not participated in international standardization before.

At present, ISO is the world's largest developer of voluntary international standards. With nearly 20,000 standards published in all fields except electrical technology, and a membership of 164 national standards bodies from so many countries, ISO standards have a considerable and growing impact on the economy of most countries.

4.2.1 ISO Membership

ISO has one member per country from 164 countries. There are three categories of members: full members, correspondent members and subscriber members. Each membership category gives certain rights and involves certain obligations.

Full members of ISO (114) include all industrialized countries and emerging economies, as well as many developing countries. Full members can participate and vote in all policy-setting organs and in any ISO technical Committee. Full members **influence** ISO standards development and strategy. They have the right to sell and adopt ISO International Standards nationally.

Correspondent members (46) are mainly members from developing or small countries. An ISO correspondent member can **observe** the development of ISO strategy by attending ISO policy meetings without the right to vote. Correspondent members can also **observe** ISO technical work and can **fully participate** in a limited number of technical committees (up to 5) of their choice. They can attend, submit comments and vote on drafts in the chosen TCs. As for the remaining ISO Technical Committees, Sub-committees and Working Groups, a correspondent member may nominate delegates and participate as an observer in any of them, but they have no right to comment or vote except in the five chosen committees. Correspondent members do not vote on international drafts outside the chosen five technical committees. They can sell and adopt ISO International Standards nationally.

Subscriber members (4 at present) are members from small and very small countries who have limited rights to observe and participate in ISO work. Subscriber members do not participate in setting ISO policy, although they may attend ISO General Assembly as observers. They can attend, submit comments and vote on drafts in not more than five committees of their choice. Subscriber members may not adopt or sell ISO standards.

A few UN members remain outside the ISO fold. However, ISO member countries generate some 98% of world gross national income (GNI) and represent around 97% of the world's population. A full list of ISO members is attached at Annex 1.

4.2.2 ISO Technical Work

ISO's technical work is mainly to develop international standards. These are developed by groups of experts delegated by ISO members who work

in technical committees, sub-committees and working groups. Drafts are then commented and voted on by ISO member bodies.

ISO has established to date 288 Technical Committees (TCs) of which 235 are active at present while 53 are on standby. A technical committee is created on proposal by a member body supported by five other full members who commit to contributing actively to the work of the committee as participating (P) members. The TCs are denoted by numbers, following the order in which they were established. For example, TC 1 focusing on screw threads was created in 1947 and TC 288 on educational management systems was created in 2013. A TC on standby is one that has no work items in progress or foreseen but that is required to review the ISO International Standards for which it is responsible.

Some of ISO TCs are known as **Project Committees**. These are established when there is a need for an international standard on a specific topic that does not fall into the scope of an existing TC. Project Committees are disbanded once the standard has been published.

ISO has two joint TCs with the International Electro-technical Commission (IEC) one of which deals with information technology (ISO/IEC JTC 1) while the other, a project committee (ISO/IEC JPC 2), deals with energy efficiency and renewable energy sources. With more than 2650 published standards in its portfolio and nearly 600 items on its work program, ISO/IEC JTC1 is the most prolific of international technical committees.

Standards published by ISO in the first period after its establishment dealt mainly with hardware. Starting in the 1980s, ISO ventured more into software standards with standards on management systems constituting an important new trend. Examples of some famous and extensively used international standards outside the field of information and communication technologies are those for quality management, environmental management, food safety management, management of social responsibility, energy management, risk management, country