



# Teaching Standards

**Good practices**  
for **collaboration** between  
**National Standards Bodies**  
and **universities**



“The development of this publication and the regional workshops which provided substantial input for it, have been funded by Sida, a government agency working on behalf of the Swedish Parliament and Government, with the mission to reduce poverty in the world. To them goes the gratitude of ISO and its members.”

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Photo : UNIGE - Jacques Erard

# Foreword

Standards are a vehicle for sharing knowledge, technology and good practices.

The nature, role and importance of standards in technology, trade, sustainability and legal matters is in itself a subject that can be incorporated in the curricula of technical universities, business schools and other faculties – and this is increasingly recognized in education programmes around the world.

But, above all, students of universities, business schools and other institutions of higher learning, are the potential managers and professional experts of the future. Whether they become engineers, economists, lawyers, business managers or administrators within central or local government, they will be the ones to gain the most advantage from standards – and the ones to decide the future role and features of standardization.

ISO recognizes the fundamental contribution that educational institutions and especially universities<sup>1)</sup> can give to standardization in terms of:

- Teaching what is and what can be achieved through standardization
- Participating in the development of standards, providing the invaluable contribution of academia's work

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1) Students at **all school levels** can benefit from the understanding of basic concepts regarding standards and standardization, and increased familiarity with such concepts would, in the long term, contribute to standards development, dissemination and use. However, **universities** are the educational institutions that **have the maximum potential** for interaction with the standards world; because they are the ultimate bridge between younger generations and professions and, at the same time, they are key producers of knowledge – important and often indispensable for new standards. For these reasons, our efforts have been and are focused on universities and other institutions of higher education – although several initiatives conducted by NSBs and ISO target other education levels.

- Developing academic studies and research work on standardization

ISO and its national standards bodies (NSBs) are, therefore, keen to support academic institutions in their efforts. Over the past few years we have developed many initiatives contributing to this aim. In particular, a series of ISO regional events, organized in collaboration with and the support of KATS, the national standards body of the Republic of Korea, have been organized to collect information, share experiences, identify good practices and success factors in developing or strengthening education about standardization in a large number of countries of the world.

Regional workshops were, in fact, organized :

- In May 2012 in Bali (Indonesia), with the support of the Badan Standardisasi Nasional (BSN), the national standards body of Indonesia
- In April 2013 in São Paulo (Brazil), with the support of the Associação Brasileira de Normas Técnicas (ABNT, the national standards body of Brazil)
- In November 2013 in Centurion (South Africa), with the support of the South African Bureau of Standards (SABS), the national standards body of South Africa

**120 people from 55 countries**, including representatives of NSBs and academics, participated in the workshops, through highly interactive sessions.

This document has been developed on the basis of the information, ideas and recommendations gathered through these workshops.

We wish to express our profound gratitude to the **Korean Agency for Technology and Standards (KATS)**, which has co-sponsored and actively contributed to the regional workshops listed above. Over the last decade, the Republic

of Korea has been a forerunner in the development and promotion of education about standardization, and they have been pleased to share the Korean experience and lessons learnt with national standards bodies and universities from many other countries.

We also wish to thank **Dr. Donggeun Choi**, Chief Researcher, International Standards Team, Korean Standards Association (KSA) and **Ms. Sunghyun Park**, Senior Researcher, Global Standardization Center, KSA, for their active involvement in the programme, their enthusiasm and outstanding contribution.

Special thanks must go to **Prof. Henk de Vries**, Associate Professor of Standardization, Rotterdam School of Management, Erasmus University (Netherlands); to his student assistant Joey Veurink and to PhD student Basak Manders. Prof. de Vries and his team carried out the study commissioned by ISO in 2011/2012 on the cooperation between national standards bodies and universities, which was used as input for the workshops.

Special thanks must also go to the national standards bodies which have hosted the workshops, **BSN**, **ABNT** and **SABS**. The quality and effectiveness of their contribution is well reflected in the high level of appreciation shown by the workshops' participants.

Finally, we must underline the fact that the development of this guide would have not been possible without the interest, passion and dedication of so many people from national standards bodies and academia; all those who have actively participated in the workshops and others, including the team from the ISO Central Secretariat. This is the result of a collective effort, the credit for which has to be shared among all the contributors.

**Daniele Gerundino**,

ISO Director of Research





# 1 Standards in university curricula – why?

## 1.1 What is a “standard”

**A standard, according to the ISO definition, is a :**

“Document established by **consensus** and approved by a **recognized body** that provides for common and repeated use, **rules, guidelines or characteristics for activities or their results** aimed at achieving the optimum degree of order in a given context.” (ISO/IEC Guide 2:2004)

This definition brings together three key elements that characterize documentary standards from the perspective of formal standardizing bodies:

- The **technical content** of the document (rules, guidelines, etc., to achieve the optimum degree of order in a given context)
- The **process** through which it is developed (by “consensus”, i.e. through the involvement and agreement of the concerned and affected parties<sup>2)</sup> – this has stringent implications on how the standards are developed, i.e. on the procedures and governance adopted by the standards developing organizations)
- The **entity responsible** for issuing the standard (a “recognized body”, usually a qualified, neutral

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2) Consensus is defined in ISO/IEC Guide 2:2004 as “general agreement, characterized by the absence of sustained opposition to substantial issues by any important part of the concerned interests and by a process that involves seeking to take into account the views of all parties concerned and to reconcile any conflicting arguments”.

organization following well-defined procedures, also known as a “due process”)

The term “standard”, however, is commonly used in many other ways. It is possible to keep a very general perspective, considering the context and the extent to which these three aspects are taken into consideration.

So, if attention is focused exclusively on technical content, one can hear of *company (proprietary) standards*, which are utilized by a single company; and of *de facto standards*, which indicate *company standards* that win, or even dominate, in the marketplace (but remain proprietary). *Consortia standards* is also a frequently used term, describing standards developed and used by a plurality of actors, but for which the level of consensus is usually restricted to the members of a consortium (not necessarily representing the views of all the concerned and affected parties). There are also many other types of standards.

A lot can be said and learnt about the different characteristics, perspectives, roles and contribution to society of the various standardization systems, as well as of the needs they represent and the specific objectives of the organizations and individuals engaged in standardization.

In any case, if we consider the technical content dimension of documentary standards and the history of standardization, it is easy to realize that standards are an essential element of the infrastructure of modern industrial societies – because they ensure (among others):

- Reliable measurement and testing
- Interchangeability of parts, compatibility and interoperability of products
- Codification of knowledge about:
  - The characteristics, properties and performances of materials, components, products and systems

- The structure and organization of processes
- Good practices for activities in given contexts
- Objective criteria and methods to assess health and safety requirements and environmental impacts

Consensus-based standards of the type developed by formal Standards Developing Organizations, National Standards Bodies and ISO – to which the ISO/IEC definition applies – represent a particularly important group of standards and we will see more about this later.

## 1.2 The importance of standards – in different contexts

### Standards and technical disciplines

The intimate link between standards and scientific and technical disciplines, and notably engineering, is evident.

Today's technical standards are the result of a two hundred<sup>3)</sup> year-long ride initiated with the Industrial Revolution in Europe – they codify the results of colossal efforts made by generations of scientists and engineers, providing the foundation for the design, manufacturing and operation of almost all the products surrounding us.

From the design of screw threads and fasteners to technical drawings, from the definition of dimensions and tolerances for mechanical parts to instructions for set-up and operation of machines, from the design, performance and safety requirements of boiler and pressure vessels or

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3) Here we are limiting our perspective to modern standards – which can be dated back to the advent of the metric system of units (end of the 18<sup>th</sup> century) and to the Industrial Revolution (19<sup>th</sup> century).



electrical devices to the specification of formats and fittings of freight containers, technical standards are omnipresent.

In each of these areas, standards not only provide the basis of good practices for designing and manufacturing good quality and safe products; they also give an important contribution to technical evolution by applying *critical design constraints*; that is, they allow to save vital design time and effort, simply by providing a stable foundation of already defined (and proven) properties, capabilities and processes.

It is not a surprise that technical standards are used in engineering courses by universities in many countries of the world.

They can be used by reference, i.e. indicating that a certain process or a device is covered by a technical standard,

by introducing the principal technical content, e.g. by highlighting the key aspects of the standard, and by direct use of a published standard (or a significant excerpt of it) in the classroom, for student assignments or in projects.

However, they are most often considered from the purely technical perspective. Engineering courses rarely provide a description of how standards are developed (except, perhaps, a very brief overview), of the characteristics of standardization systems and of standards development practices. And they do not address at all the soft skills needed in standardization – a very important aspect that we will consider later.

### Standards and other disciplines

In the World Trade Report 2005 *Trade, standards and the WTO*, it is noted that “we live in a world profoundly reliant on product standards. They affect our lives in ways we sometimes do not even notice, but they can have far-reaching implications for economic activity, including trade.”

The WTO also notes that “The attention given to the trade impact of standards has sometimes obscured the important role that standards play in increasing economic efficiency and dealing with market failures. It is in performing these functions that they create societal benefits.”

Economists have studied the role and impact of standards on society and have observed that standards give an important contribution to public welfare by:

- **Improving economic efficiency:** ensuring interchangeability of parts and supporting variety reduction, standards drive economies of scale. Enabling compatibility and interoperability, standards allow the establishment and exploitation of network effects, foster the development of markets for materials and

product components, as well as for complementary products

- **Limiting market failures:** by reducing the *information asymmetry* between buyers and producers through information, measurement and minimum quality standards, and by helping to contrast *negative externalities* (such as environmental impact) through quality, safety and environmental standards
- **Promoting trade:** by facilitating access to markets (through the harmonization of requirements and conformity assessment practices), reducing transaction costs (through reliable information about material and product characteristics and performances), and facilitating the establishment and operation of (global) supply chain networks

This general perspective provides a good basis for understanding the importance of standards in relation to a variety of fields and academic disciplines. In what follows, we will give a quick outline with relation to some of them.

## Strategy and entrepreneurship

Internationalization of businesses is a key factor in today's competitive landscape. Far-reaching strategic vision and thorough operational implementation are essential for the success of companies. Entrepreneurship plays an essential role as an agent of change, a generator of economic development and new jobs.

Standardization plays a significant role in these domains, even if it is often neglected. Standards-related issues are often strategically important in relation to:

- Choices regarding the development of technologies and their dissemination
- Innovation management

- The establishment and exploitation of network effects
  - with particular consideration for the complexity and extension of today’s supply chains
- Access to international markets
- Optimization of company processes
- Compliance with regulatory requirements (existing, expected or uncertain)
- Consumer confidence
- Sustainability management

## Innovation

Innovation is widely recognized as one of the essential drivers of successful business and a key contributor to a nation’s productivity and economic growth. Finding ways of fostering innovation is a central concern for both forward-thinking companies and governments. In many countries there is a strong focus on public funding of research and development and on intellectual property rights (IPR) as instruments of innovation policy and business strategy.

Whilst it is clear that commercial and economic results from research can only be achieved through their successful transfer into innovative products and processes, this critical aspect – which is the one to which standardization contributes most – is often neglected.

However, an increasing number of researchers and decision makers are aware that standards can help innovation in a number of ways:

- Contributing to technical evolution by applying, at the right time, critical design constraints (i.e. avoiding *re-inventing the wheel*). They can help to reduce wasteful, redundant product development – thus freeing up resources that can instead be dedicated to fresh, inventive work

- Facilitating the development of new markets and trade; by helping to establish and exploit network effects (an issue that concerns ever more industries and regions of the world, given the escalation in scope and complexity of global supply chains), increasing consumer confidence, helping to reach critical mass
- Permitting the sharing of investments and risks associated with the development of new technologies and applications (innovation through collaboration)
- Helping the commercial exploitation of innovative ideas, providing a basis for dissemination of information and an accepted framework within which patents can be drawn up, removing undue proprietary interests and barriers to trade

## Public policy

Whilst there is some room for other types of standards in this context, when we consider the relation with public policies, we need to focus attention on the type of standards developed by ISO and other formal standards-developing organizations. As written *agreements* on the use of technologies, methods or processes adopted by *consensus* by the concerned parties for consistent use in a given context, following a *due process* characterized by openness, transparency and impartiality, standards have a long history of relations with public policies: most often they are seen as *complementary* to public policies, and in a number of cases they can be considered as an *alternative* to mandatory requirements.



The strongest, longest-dated connection is certainly with technical regulations<sup>4)</sup>, but standards can be considered in relation to other types of public policy such as public procurement, or legislative frameworks (including incentives or penalties) promoting competition, innovation, consumer protection or sustainability.

Standards are considered efficient and cost-effective tools that can support the implementation of public policy in a large variety of fields. They offer public authorities advantages such as:

- Help in supporting cooperation and potential harmonization (especially at international level) of public policy in the fields concerned
- Immediate access to a large portfolio of documents providing sound technical knowledge formalized by recognized experts in a broad variety of fields, based on consensus from a balance of interests reflecting technological, economic and public interest conditions
- The opportunity to develop technical solutions addressing requirements and priorities set by public authorities, involving all the concerned parties in an open, transparent and efficient process

Standards are also considered an element of good public governance; the OECD good regulatory practice (2012) makes explicit reference to standards in relation to: Regulatory Impact Assessment (RIA) (“...Ex ante assessment should in most cases identify approaches likely to deliver the greatest net benefit to society, including complementary

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4) According to ISO/IEC Guide 2:2004, a *regulation* is a “document providing binding legislative rules, that is adopted by an authority” and a *technical regulation* is a “regulation that provides technical requirements, either directly or by referring to or incorporating the content of a standard, technical specification or code of practice”.

approaches such as through a combination of regulation, education and voluntary standard”) and to the planning of regulations (“in developing regulatory measures, give consideration to all relevant international standards and frameworks for co-operation in the same field and, where appropriate, their likely effects on parties outside the jurisdiction”).

## International trade

As already indicated, standards facilitate trade. In particular, the use of International Standards is considered an important mechanism to support the elimination of unnecessary barriers to trade.

The contribution that International Standards can give in this respect is strongly recognized by the World Trade Organization, through the WTO/TBT (Technical Barriers to Trade) Agreement. For the purpose of this document, it is sufficient to recognize that WTO members are requested to use existing international standards as a basis for technical regulations:

### *Article 2.4*

“...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...”

and, by doing so, their technical regulations will be presumed not to create unnecessary trade barriers:

### *Article 2.5*

“... 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... .”



## Sustainability

We have noted before that standards are an essential element of the infrastructure of modern industrial societies. In a similar way, we believe that standards can be an essential component of the emerging infrastructure of a new, sustainable world.

Sustainable development processes need the active involvement of all the parties likely to contribute to, or to be affected by, them. In both academic and policy circles, there is now broad agreement that promoting sustainable development requires a systemic perspective on the long-term consequences of present policies for tomorrow's environment, economy and society.

Participatory processes involving public and private actors situated at various levels of the socio-economic spectrum are particularly important. Standard-setting practices are seen as a mechanism helping to create essential voluntary agreements that support the dissemination of knowledge, best practices and monitoring tools.

Standardization can, therefore, give a substantial contribution to re-evaluating:

- The design of products aiming to minimize materials and energy consumption through the entire lifecycle
- The way materials are created and used
- The impact of human activities on the environment
- Economic and social models, aiming to preserve natural capital and to increase human and social capital

### 1.3 Knowledge of standardization adds value

We have seen that standards are addressed in university programmes covering **technical disciplines**.

However, with some notable exceptions, they are most often considered from a narrow technical perspective.

This is no longer sufficient. Standards are becoming ever more important for professionals with technical backgrounds because of the increasing complexity of new products and the importance of complex systems such as smart grids, supply chain networks, home care systems for the elderly, where standards specify the interfaces between system elements.

Standardization is a rich and complex domain, which requires sound technical and business knowledge, combined with *soft skills* (interpersonal communication, behaviour in a consensus-oriented – often international and multi-cultural – environment, negotiation and lobbying in that context), knowledge



“I am a professor engaged in the research and teaching of international trade, where the influence of standardization is growing. A

lack of knowledge of standardization will adversely impact the competence and working ability of international trade students. Therefore, a standardization education for majors in international trade is very important.”

#### **Jin Xuejun**

Professor, Zhejiang University,  
Hangzhou, China

about public policies in selected areas and, in some cases, legal competence. Senior managers from companies actively involved in standardization often underline the sophistication of the tasks facing company professionals who need to carefully balance pre-competitive work, helping to set frameworks benefiting all market players, with key value-adding activities in which their companies seek competitive advantage.

This is even truer for **other disciplines** – in particular, those covered by schools of management or faculties of economics and social sciences.

Many leading universities and business schools throughout the world address the growing need in the job market for trained and competent international business leaders. Advanced education (especially post-graduate) is keen to provide skills in international business, strategy, entrepreneurship, and innovation management, which are at the heart of modern business. This concerns not only *traditional* business schools, but more and more often professional fields (including engineering and many interdisciplinary programmes), for which business strategy, innovation management and entrepreneurship skills are seen as important complements to technical knowledge.

Yet the knowledge of standards – which, as we have seen, plays a significant role in most of these areas – is rarely a significant component of such curricula. It is time for the academic world to build or strengthen links with the world of standards.



Photo - UNIGE - Jacques Erard

## 2 Teaching standardization in universities

### 2.1 Standards and university curricula – one size does not fit all

In spite of the broad scope and the vast impact of standards in today's society, standardization is still not yet a well-defined, established discipline from a theoretical or academic perspective. There are various approaches and characterizations proposed by researchers in different disciplines and by experts and practitioners from different

countries and organizations. The lack of an agreed theoretical model, and of key references in literature underlying the field, has sometimes been indicated as one of the reasons why a *standardization* academic discipline is still missing.

The development of such theoretical foundations would certainly be desirable, but discussing this aspiration is not the purpose of this guide.

There is already a vast body of knowledge and experience gathered by organizations and individuals that can be (and is already being) used



“Why education in standardization? Because it is a powerful way to communicate, in a structured manner and at different

levels, that standards can truly help to improve people's lives and the society as a whole, and to make consumers more responsible and conscious about quality, environmental and social issues.”

#### **Carlos Santos Amorim Junior**

Director of External Relations; ABNT  
(National Standards Body of Brazil)

effectively to support academic programmes. Researchers, standards-developing organizations (including ISO) and other bodies are also contributing to the development of new studies and teaching materials at a fast growing rate.

Objectives, scope, type of content and approaches for teaching standardization can vary considerably in relation to the specific context where the teaching takes place (e.g. country, faculty and specialization, teachers' and students' expectations, job offerings, available resources and expertise).

## How standardization can fit in university programmes

Technical subjects **embedded** in courses dealing with specific disciplines (i.e. reference to standards or use of standards in relation to a specific technical matter). Dedicated *lectures, workshops, student assignments, games or simulations*, covering one or more aspects of standardization – included in one or a variety of courses.

**Standardization course(s)** focused on certain aspects of standardization or a combination of them (e.g. general introduction to voluntary standards; standards applied in a specific sector; standards development processes; standards and trade; standards and public policies; standards and sustainability, etc.) which can be part of one or more university curricula.

Part of a **specialized academic curriculum**, for which standardization is among the core matters of the curriculum (Bachelor's or Master's degrees, doctoral specializations).

Standardization can be taught in the framework of undergraduate, master or doctoral programmes, as:

- A particular topic embedded in courses dealing with specific disciplines (such as electrical, mechanical or civil engineering; economics or business strategy, etc.)





“Standards have been very important in the codification of good practices in software and systems engineering, as well as IT

Governance and IT Service Management. It is thus normal that they will, explicitly and implicitly, contribute to the course material and curricula in these disciplines, as well as be the topic of research in these areas.”

### **François Coallier**

Ph.D., ing./Eng. Directeur du développement technologique et des services académiques/Chief Information Officer, École de technologie supérieure, Montreal, Canada.

- A topic addressed through a dedicated lecture, or workshop or student assignment, linked to one or more courses
- A specific subject matter, e.g. through a *standardization* course that can fit into several curricula (as a *mandatory* or *elective* course)
- A significant part of an academic curriculum (comprising a certain number of courses focused on or dealing extensively with standards-related matters)
- A specialized academic curriculum (i.e. a Bachelor’s or Master’s degree in *standardization, metrology or quality*, where standardization is among the core matters of the curriculum ; or as a doctoral specialization)

All these approaches are valid ; **one size does not fit all.**

Depending on the specific objectives and local conditions, any of these approaches can generate significant added value for the concerned parties.

## 2.2 Examples of standardization in university curricula

This section provides examples of different approaches and experiences of how standardization education can be addressed by universities.

### 2.2.1 Synergies and cross-fertilization among standardization, education and research – *École de technologie supérieure (ÉTS)*, Montreal, Canada

The *École de technologie supérieure* (ÉTS) is an engineering school offering undergraduate and graduate



programmes in engineering. Founded in 1974, the ÉTS is part of the Université du Québec network. Specialized in applied teaching in engineering and technology transfer to companies, it produces engineers and researchers who are recognized for their practical and innovative approach. It is Canada's third largest engineering school by number of graduates.

The first undergraduate programme in software engineering was introduced in 2001, and the Department of Software and IT engineering was then created in 2004.

The software engineering programme was designed upfront using the SWEBOK (Software Engineering Body of Knowledge) – which was concurrently developed with the key participation of three professors. This document



was later submitted to the international standardization process and became ISO/IEC TR 19759:2005, Software Engineering – Guide to the Software Engineering Body of Knowledge (SWEBOK).

Most of the core group of professors involved in the Department of Software and IT Engineering had already been active in the development of standards since their days in industry.



“Software engineering is an engineering discipline quite different from others. Traditional engineering disciplines

have as a foundation the laws of nature. In software engineering, we, unfortunately, do not have laws of nature as a foundation: this is why standards are vital for both the education of future software engineers and for the development of products so important to our daily activities.”

**Claude Y. Laporte**

Professeur, ing., Ph.D./ Professor, Eng., Ph.D., *D. honoris causa*, École de technologie supérieure, Département de génie logiciel et des TI/Department of Software and IT Engineering, Montreal, Canada.

Professor	Involvement in standardization
Alain Abran Pierre Bourque	▶ Co-editors of the Software Engineering Body of Knowledge (SWEBOK) – ISO/IEC TR 19759
François Coallier	▶ Chair of ISO/IEC JTC 1/SC 7 since 1997
Alain Abran	▶ Secretary of ISO/IEC JTC 1/SC 7 from 2002 to 2004. ▶ Editor of ISO/IEC 19761 and ISO/IEC TR 14143-3
Witold Suryń	▶ Secretary of ISO/IEC JTC 1/SC 7 since 2004 ▶ Co-editor of ISO/IEC 25000 ▶ Editor of ISO/IEC 25001 and ISO/IEC 25023. ▶ Canadian delegate to SC 7/WG 6 for over 10 years
Claude Laporte	▶ Project editor of JTC 1/SC 7 WG 24 since its establishment in 2005. ▶ Working group 24 developed the set of ISO/IEC 29110:2011 standards and technical reports for very small entities
Alain April	▶ Canadian delegate to JTC 1/SC 38 for Cloud Computing

At the ÉTS Department of Software and IT Engineering, standards are **embedded in undergraduate programmes and graduate programmes** – as a source of good practice and documentation on the body of knowledge.

This is done in multiple courses, on topics ranging from SQA (Software Quality Assurance) to IT security and software testing and maintenance – as shown in the list below.

Course	Title	Standards used
GTI510	Project Management and Quality Assurance	ISO/IEC 15288 ISO/IEC TR 9126 series
GTI719	Security of Enterprise Networks	ISO/IEC 27002
LOG330	Software Quality Assurance	ISO 9001 ISO/IEC 90003 ISO/IEC 12207 ISO/IEC 16085 ISO/IEC/IEEE 24765 ISO/IEC 29110 series ISO/IEC TR 19759 IEEE 1012 IEEE 730 IEEE 1028
LOG430	Software Architecture	ISO/IEC 12207

<b>Course</b>	<b>Title</b>	<b>Standards used</b>
<b>LOG515</b>	Software Project Management	ISO/IEC 15288 ISO 9128
<b>LOG240</b>	Test and Maintenance of Software	ISO 9001 ISO/IEC 12207 ISO/IEC 14764 ISO/IEC 20000-1 ISO/IEC 20000-2 ISO/IEC TR 20000-5
<b>MGL800</b>	Software Project Management	ISO/IEC 90003 ISO/IEC TR 9126 series ISO/IEC 12207 ISO/IEC 15939 ISO/IEC 19761 ISO/IEC/IEEE 16326
<b>MGL804</b>	Software Maintenance	ISO/IEC TR 19759 ISO/IEC 14764 ISO/IEC 15504 series
<b>MGL805</b>	Software Quality Assurance	ISO/IEC TR 9126 series ISO 9001 ISO/IEC 12207 ISO/IEC 25000 ISO/IEC 16085 ISO/IEC/IEEE 15289 ISO/IEC 15939 ISO/IEC 29110 series ISO/IEC/IEEE 24765 ISO/IEC TR 19759
<b>MGL841</b>	Software Measurement	ISO/IEC 9126 series ISO/IEC 19761 ISO/IEC 15939 ISO/IEC/IEEE 16326
<b>MGL842</b>	Software and System Quality Engineering	ISO/IEC 9126 series ISO/IEC 14598 series ISO/IEC 25000 ISO/IEC 15288 ISO/IEC 12207 ISO/IEC 15939

Course	Title	Standards used
MGL950	Case Study	ISO/IEC 12207 ISO/IEC 29110 series ISO/IEC 15504 series ISO 9004 ISO/IEC TR 24774 ISO/IEC/IEEE 24765 ISO/IEC TR 19759

Over the years, standards – and particularly topics addressed in or leading to the development of new standards – became a research subject, for both Master’s and PhD students. Many Master’s and PhD projects and theses at ÉTS are pursued around the development of standards, their evolution and their application – followed by academic publications.

### 2.2.2 A Chair in Standardization – Rotterdam School of Management, Erasmus University, Rotterdam, The Netherlands

Rotterdam School of Management is the international business school of the Erasmus University located in Rotterdam, The Netherlands. Ranked as one of the leading European business schools, it offers undergraduate and postgraduate programmes including MBA, Executive Education and PhD programmes.

Since January 1994, the RSM has hosted a **Chair in Standardization** – an endowed<sup>5)</sup> chair funded by the Netherlands Standardization Institute (NEN), the Dutch national standards body. The Chair of Standardization belongs to

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5) A position permanently paid for with the revenue from an endowment fund specifically set up for that purpose.



Photo: Vysotsky

the Department of Technology and Operation Management, one of the seven academic departments of the RSM.

The standardization education activities of the Chair cover graduate and undergraduate programmes through :

- Courses (Bachelor's and Master's levels) in which a substantial part of the content is related to standardization
- Master's thesis projects (which can be pursued by students of the various MSc programmes offered by the RSM)
- PhD projects
- Executive courses



In 2013, two Master’s elective courses were given by the Chair in Standardization:

Course	Title	Level – ECTS credits
RSMME066	Business Process Excellence	MSc – 6 credits
RSMME047	Innovation and Interface Management	MSc – 6 credits

The first course (Business Process Excellence) has been scheduled since 2003 and the second one (Innovation and Interface Management) since 2007.

In previous years, several bachelor elective courses covering standardization topics had also been run – a list of the most important ones is given below:

Course	Title	Level – ECTS <sup>1)</sup> credits
<b>BKBBTH (13, 13a, 12, 15) From 2007 to 2012</b>	<i>Standaard of Maatwerk</i> (“Standard or Custom” – covering the balance between standardized and customized approaches in companies)	BSc 3 – 12 credits
<b>BKBBTH07 2013</b>	<i>Keurmerken – Hoe bewust kiezen consumenten?</i> (How certification marks influence consumer decisions)	BSc 3 – 12 credits

1) The European Credit Transfer and Accumulation System (ECTS) is a system used to classify courses and programmes allowing to compare higher education qualifications across Europe.

Cooperation has also been established between Leiden University, Delft University of Technology and Erasmus University, Rotterdam, on a minor programme covering *Responsible Innovation*. Standardization is integrated into this 30 ECTS credits programme provided in English (Code: WM-Mi-180-14).

Master’s thesis: students can devote their thesis to standardization. In many cases, this is combined with an internship in a company or an organization. Some students have managed to win national best thesis awards and some

theses have formed the basis for publications in scientific and professional journals.

Examples of recent topics addressed in MSc theses by RSM students :

- ISO 9001 impact – literature review of case study research
- Intermodal road-rail transport ; possibilities for standardization ?
- Certification seal for sustainable tourism – Support by entrepreneurs at the Isle of Texel
- Supporting innovation management through involvement in standards development
- Standards’ battles – the case of smart phones
- The impact of ISO 14001 on the environmental performance of firms
- The role of perceived risk in signaling quality : A study on certification seals and benefit claims
- Business model innovation NEN Publishing
- Double standardization in the wood supply chain
- Standards’ battle in textile communication
- Implications of quality considerations on food supply chains : An analysis of the German retail market
- Standardization in the French wine industry – loss of authenticity?



“The standardization courses helped me to comprehend the importance of standardization and how it can help business to

move forward. In my professional career I’m dealing with standardization on a daily basis; both process and product related standardization. Everyday I benefit from the standardization practices I learned through the standardization courses of my Master study at the Rotterdam School of Management, Erasmus University.”

**Sander van der Toorn**

Business Process Engineer at IHC Merwede (Shipyards), graduated from RSM



“With standards education, I learned about the strategic impact of standardization and of how often this is underestimated.

Many other organizational levers are often more complex or require more resources to execute. Working in a dynamic organization seeking economies of scale, one of my key preoccupations when taking any business decision with regard to processes or product development is the drive to standardize. I am convinced that as people become more aware of and understand standardization through ongoing and extended education, the impact of standardization on business will be more powerful.”

### **Najim Argam**

Commercial Excellence and New Product Management, AkzoNobel Performance Coatings & Specialty Chemicals, graduated from RSM

- Business Impact of ISO 22301 Business Continuity Management (winner of two best thesis awards)

PhD projects : PhD trajectories are primarily research but can be seen as a form of education as well. Several RSM PhD students have focused their interest on standardization, covering subjects such as :

- Standards battles
- Standardization and authenticity in hospitality services
- Impact of standardization on innovation
- Business impact of ISO 9001
- Participation in international standardization



### **2.2.3 Multiple courses and a specific undergraduate programme in standardization China Jiliang University (CJLU), Hangzhou, China**

China Jiliang University (formerly the China Institute of Metrology, the science of measurement) was established in 1978 and is the only university qualified to offer Bachelor's and Master's degrees in the fields of Quality Supervision, Inspection and Quarantine in China. The primary area of specialization of CJLU is engineering. However, CJLU is now a comprehensive university that offers programmes in various disciplines, including engineering, science, management, law, economics, literature, medicine, art and philosophy.

CJLU is organized into 18 colleges offering 49 academic majors. It runs 36 Master's programmes, mostly focused on



“As a graduate student of quality management and standardization engineering, after years of study I deeply realize the close

relationship between standardization and quality. Standards are the foundation and quality is the goal. The study and implementation of standards not only guarantee but also help to improve the quality of products. “

**Huang Jia**

Graduate student, China Jiliang University, Hangzhou, China

engineering, including a Master’s programme in quality science and standardization engineering.

Standards are embedded as specific subject matters in many engineering courses. However, five colleges cover standardization, metrology and quality in an extensive way :

- College of Metrology and Measurement Engineering
- College of Quality and Safety Engineering
- College of Economics and Management
- College of Law
- College of Standardization

In particular, the College of Standardization offers a Bachelor’s degree in Management, with a major in **Standardization Engineering**.

An overview of the Standardization Engineering programme is given below.

Category of Courses	Name of Course	Study Hours
<b>Basic Courses</b>	College English	172
	Advanced Mathematics	172
	Probability and Statistics	48
	Linear Algebra	48
<b>Engineering and Technology</b>	Physics	64
	Chemistry	32
	Electrotechnics and Electronics	48
	Mechanical Design	48
	Measurement Technology	32
	Engineering Cartography	32
<b>Economics and Management</b>	Microeconomics	48
	Macroeconomics	32
	Theory of International Trade	32
	Management Theory	32
	Marketing	32
	Financial Management	32
	E-Commerce	32
<b>Fundamental Courses Related to Standardization</b>	Metrology	32
	Evaluation of Measurement Uncertainty	32
	Reliability Engineering	32
	Statistical Processing Control	32
	Design of Experiment	24
	Quality Management	48
<b>Theory and Methods of Standardization</b>	Standardization Principles	32
	International Standardization	32
	WTO/TBT-SPS and Technical Barriers to Trade	32
	ISO 9000 Family of Standards and Quality certification	32

Category of Courses	Name of Course	Study Hours
Theory and Methods of Standardization	Environmental Management System Certification and ISO 14000 Standards	24
	ILIAS E-Learning Platform	16
Field Practice of Standardization	Electrotechnics & Electronics Practice	2 weeks
	Metalwork Practice	2 weeks
	Standardization Internship	4 weeks
	Pre-graduation Project about Standardization	13 weeks



“As standardization is playing an increasingly important role in economic and social development, industry

needs more and more talents in standardization. Students who have graduated from our standardization major are favored not only by enterprises but also by government departments and social management organizations. Our graduates are in short supply!”

### **Song Mingshun**

Professor, China Jiliang University,  
Hangzhou, China

As indicated in the overview, classroom courses and group work are complemented by field practice, which requires the consideration of sector-specific standards issues, internships in standards organizations or in industry and the development of an original standardization project.

Students in senior classes are also encouraged to take the internal auditor of ISO 9001 examinations.

Since its establishment, over 2 000 students have graduated with a Bachelor’s degree in management, and a major in standardization. The vast majority of them have found jobs related to standardization.

#### 2.2.4 Standardization as a key component of a Master's programme, University of Geneva, Switzerland

Founded in 1559 by Jean Calvin, the University of Geneva (UNIGE) is Switzerland's second largest university, with 16 000 students of more than 140 different nationalities. UNIGE offers more than 280 types of degree and more than 250 continuing education programmes covering a wide variety of fields: exact sciences, medicine and humanities.

In 2011, UNIGE launched the first edition of the **Master in Standardization, Social Regulation and Sustainable Development**, developed and operated in partnership with the International Organization for Standardization (ISO) and the Schweizerische Normen-Vereinigung (SNV, the Swiss national standards body).

The programme is run under the auspices of the faculty of Economics and Social Sciences and brings together in a single curriculum three thematic pillars: standardization, sustainable development, and social regulation.

#### Rationale

The programme focuses on sustainable development and on the notion that sustainable development processes need the active involvement of all the parties likely to contribute to, or to be affected by, them. It underlines the importance of the participatory processes involving public and private actors situated at various levels (social regulation), including the standards-setting practices that provide essential voluntary agreements supporting the dissemination of knowledge, best practices and monitoring tools.

Standards-setting practices play an important role in the new social regulation architecture. Actors often coordinate by voluntarily agreeing on standards, which





Photo: UNICE - Valentin Savigny

are then monitored through the collection of data on the performance of local actors and the creation and diffusion of reports and indicators that track the actors' progress towards sustainability.

## Structure

The Master's programme is eminently interdisciplinary. It involves at least three disciplines : sociology, management and economics.

The programme is divided into four blocks. The first and largest block comprises the foundation courses (15 in total). The second deals with standardization activities and their effects (five courses). In the third block (five courses), students are offered a choice of elective courses which can be taken from among those offered by other Master's programmes of the University of Geneva. The fourth and last block concerns the students' internship and thesis.

From a practical standpoint, the programme is a *Specialized Bologna Master's* (90 ECTS credits). It is organized into three semesters of courses with an additional semester devoted to an internship. All courses have a total duration of 24 hours and are worth 3 ECTS credits each.



“The Master in Standardization, Social Regulation and Sustainable Development at the University of Geneva, implemented in collaboration

with ISO, is based on the notion that standards do not just facilitate technical coordination within and across borders, but also catalyze the energies of multiple actors around shared goals. For the students in the Master's, standards are much more than technical devices.”

### Lucio Baccaro

Full Professor, Sociology Department, University of Geneva – Director of the UNIGE/ISO Master programme

Programme Blocks	Name of Course	Credits
Foundational Courses	Quantitative Methods <i>Basic course in multivariate methods for social scientists</i>	3
	Development <i>Introductory course on development, both economic and social aspects</i>	3
	Economics of Globalization <i>Introduction to international trade, finance, and macroeconomics</i>	3
	Environmental Economics <i>Political economy of standard-setting activities in international organizations, particularly in the labour, environmental and trade fields</i>	3
	Governance and Public Policy <i>Comparative participatory governance and public policy course</i>	3
	Organizations <i>Sociology of organizations</i>	3
	<b>Voluntary, Consensus-Based Standards</b> <i>Theory and practice of voluntary standards</i>	3
	The Socio-economic Impact of Globalization <i>Impacts on poverty, employment, inequality, etc.</i>	3
	Governance of Global Supply Chains <i>The evolution of global supply chains, private monitoring, certification procedures, etc.</i>	3
	Global Health <i>Issues in national and global health policy</i>	3
	Labour Market Policy <i>Issues in national and global labour market policy</i>	3

Programme Blocks	Name of Course	Credits
Foundational Courses	Environmental Policy <i>Issues in national and global environmental policy</i>	3
	Policy, Programme and Project Evaluation : Methods and Practice <i>Public policy evaluation methods</i>	3
	Sociology of Contemporary Capitalism <i>Varieties of capitalism course</i>	3
Operational Courses	Corporate Social Responsibility <i>Social issues in business course</i>	3
	<b>Strategic Planning of Sustainable Business</b> <i>Planning and managing sustainability within the framework of corporate strategy</i>	3
	<b>Management Systems for Sustainability</b> <i>Management systems for quality, environmental protection, energy, waste, etc.</i>	3
	<b>Impact Assessment and Risk Management</b> <i>Objectives, approaches, practices and instruments of risk management</i>	3
	<b>Conformity Assessment</b> <i>How to evaluate compliance with standards : New trends in auditing and accounting</i>	3
Elective courses	To personalize their Master's programme, students should select five courses offered by the following Master's: <ul style="list-style-type: none"> <li>▶ Master of Science in Management (HEC)</li> <li>▶ Master of Science in Economics</li> <li>▶ Master of Science in Public Management (MAP)</li> <li>▶ Master of Science in Environmental Sciences</li> </ul>	3 × 5

Programme Blocks	Name of Course	Credits
Thesis – Internship report	The internship is available to all students having successfully completed the first year of the Master’s programme. Students can only start an internship after having achieved 60 ECTS credits according to the study plan.	18

### The ISO contribution

The ISO contribution to the Master’s programme consists in five mandatory courses (one fundamental and four operational) – highlighted in bold in the list above.

These ISO courses provide a general introduction to standardization, covering the essential elements of theory and practice of voluntary standards. They describe the role that International Standards have in supporting the dissemination of sustainable business practices, provide specific information on a plurality of management standards and their applications, and address the theme of conformity assessment.

The overall ISO contribution is coordinated by Daniele Gerundino, ISO Director of Research. The ISO courses are delivered by ISO/CS staff (D. Gerundino, R. Weissinger, N. Fleury and S. Maccurtain) and enriched by the contributions of over 15 external lecturers, including senior managers from international organizations, private companies, NGOs, think tanks and professors from other universities.



# 3 Cooperation between national standards bodies and universities

## 3.1 Rationale

ISO and national standards bodies firmly believe that teaching what is and what can be achieved through standardization is extremely important, because:

- Knowledge, skills, attitudes and experience in standardization add value to professions and roles in a large variety of fields
- Teaching standardization increases students' awareness of the nature, impact and benefits of standards to markets and society, improving their ability to contribute to company performance and public welfare. In turn, this contributes to strengthening standards development, dissemination and use

Several universities and other institutions of higher learning have already embraced this concept and understand that teaching standards and standardization adds value to the qualification of students in various disciplines – contributing to improving the university's performance in meeting private and public sector needs.

However, there are many more institutions that are not yet aware of the potential of teaching standardization, or of the broad set of issues addressed by standardization and of their relevance to a number of mainstream disciplines.

ISO and NSBs are, therefore, keen to raise awareness of the importance of standardization and to support universities

in addressing standards matters in the framework of their programmes. Educational institutions considering standardization as a potentially interesting topic can benefit from cooperation with standards developing organizations, because they can :

- Make it easier to teach this subject (through the availability of teaching materials, standards publications, qualified lecturers and other resources)
- Facilitate research on standards-related topics (through direct access to relevant information, access to a broad network of stakeholders, funding or other forms of support)

## 3.2 Any country can do it

Through the ISO regional events organized in 2012 and 2013, we have learnt from the experiences of a large number of countries of different sizes and levels of development.

Effective initiatives can be (and often *are already*) pursued even by NSBs with very limited resources, operating in difficult conditions and missing real support or recognition by public authorities. The scale and the impact of such initiatives vary greatly and obviously the availability of resources and support from public authorities and other key stakeholders makes a big difference (and communication aiming to achieve this support is indeed an important action for NSBs, as we will see later). Some NSBs feel that lack of resources and endorsement by public authorities make it impossible to take any initiative targeting universities.

However, we wish to underline the fact that any NSB, no matter how serious the limitation of resources or other



obstacles, can make useful and important progress in this area, by setting realistic objectives and adopting a proactive approach. The roadmap outlined in section 3.4 provides guidance on how to develop a successful approach – something that is relevant to all NSBs.

### 3.3 Forms of cooperation

Many forms of cooperation between NSBs and universities exist, although their application (and the level of impact) differ significantly from country to country.

In this section we have tried to classify the existing forms of cooperation, grouping activities that involve or address the same actor, issue or organizational entity.

#### University courses

- Teaching materials covering standards-related matters (presentations, case studies, articles, book sections, etc.). Various forms of cooperation are possible: materials can be provided by the NSB directly or through a third party (e.g. a company, a standards expert, a researcher). They can be jointly developed by the NSB and the university (with or without some cost-sharing agreement), or commissioned by the NSB to the university
- Guest lectures: usually given by NSB staff or by standards experts (participating in committee work), often contacted through the NSB
- Workshops or other special events relevant for one or more university courses – usually organized by the NSB or with the support of the NSB

## Professors and other academics

- Participation of academics in standards development activities : NSBs can promote and support their participation in many ways [e.g. communication, networking, reduced fees or no cost, if participation in Technical Committees (TCs) requires a fee]
- Awards or other forms of recognition to academics for their contribution to standards development
- Promotion of the recognition of contributions to the drafting of standards by institutions, as an element of qualification (similar to publications in recognized journals)
- Organization of information sessions/training for academics to familiarize themselves with standardization

## Students

- Organization of students' visits to the NSB's premises to familiarize themselves with what the NSBs do
- Internship projects with NSBs or with stakeholder organizations
- Awards, competitions or other forms of recognition of students' accomplishments in relation to standards-related matters – organized by the NSB or by the NSB in partnership with the university

## Communication

- Information resources such as a website covering education in the field of standardization or a web community in the same field
- Organization of a national network of people interested in standardization education (which can include

university professors, students, standards experts, NSB staff and stakeholder representatives)

- Publications or news (published in NSB or university publications) regarding standardization education

## Services from universities to NSBs

- Laboratory testing for products or processes covered by standards
- Training of NSB staff
- Training of committee members
- Research, studies for and/or advice to NSB



## General and specific agreements with universities

- Special conditions for using standards (for free or for a reduced fee)
- Financial support from the NSB (or from third parties through the NSB) to develop and/or run standardization courses, or to establish chairs on standardization
- General agreements (Memorandum of Understanding) that specify *who does what* (i.e. the scope and activities of the cooperation and related responsibilities), *who pays what* (financial commitments), legal responsibility (concerning intellectual property or other aspects)
- Projects or programmes supported by public authorities or other bodies (such as donor agencies) aiming to introduce or to promote standardization education in universities
- Qualifications in standardization included in the requirements for what students need to know once they leave university

## NSB's commitment

- Staff members dedicated (full- or part-time) to promoting and supporting education about standardization
- Training of academics
- Standardization education included in national standards strategy and NSB strategy implementation plans
- Endorsement (sometimes supported by specific funding) by public authorities or other stakeholders of the NSB's plans concerning standardization education

## **10 forms of cooperation most frequently mentioned by NSBs and universities (ISO/Erasmus survey, 2012):**

- ▶ Participation of academics in standards development activities
- ▶ Visits of students to NSB offices
- ▶ Guest lectures given by NSB staff
- ▶ Student participation in internship projects within standards institutes
- ▶ NSB facilitation of contacts between academics and committee member experts (who can provide guest lectures and materials)
- ▶ Education about standardization as an element of the national standards strategy
- ▶ Organization of conferences/workshops to support or stimulate education about standardization
- ▶ Provision of technical expertise by universities for studies carried out or commissioned by NSBs
- ▶ Assignment to selected NSB staff members of specific tasks to promote and support education about standardization by universities
- ▶ Provision of standards is provided to universities for free or for a reduced fee

The above list is rather comprehensive and includes almost all the forms of cooperation practiced by NSBs and universities, according to the information gathered by ISO through surveys and dedicated regional workshops (in 2012 and 2013). As a checklist, it can be consulted to identify activities that might be relevant for a given NSB. However, the most important aspect is to consider how the various forms of cooperation can be developed and how some of them can go together in the framework of a phased approach – as we shall see in a moment.

But before addressing this point, let us consider what is the current situation, i.e. to what extent is cooperation with universities practiced by NSBs.

Considering the period between mid-2012 and end 2013 (the timeframe during which ISO has collected information), it is possible to observe<sup>6)</sup> that only very few countries do not have in place any form of cooperation with universities.

### For nearly all NSBs:

- Some academics participate in standards development activities (at least in some areas) and for the vast majority of NSBs other forms of cooperation have been established
- Visits of students to NSB offices, lectures given by NSB staff members and committee experts for university courses and facilitated access to standards for universities

This is important because, as we shall see, all countries can move from at least an already existing minimum level of relations with universities or with academics.

A **smaller number of NSBs** have then implemented additional forms of cooperation, including:

- Organization of conferences/workshops covering the theme of standards and education (in some cases, funding the participation of university professors)
- Various forms of award/recognition for professors participating in standards work with successful

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6) Given the differences and nuances of each specific case, it is not possible to provide a precise quantitative summary – but the qualitative picture presented here is sufficient for the objectives of this document.

- achievements and for students with outstanding performances (typically through competitions)
- Development of teaching materials – usually for lectures covering standardization issues in selected technical fields
  - Funding the participation of university professors in standards development activities

For **most of the ISO members**, however, the existing forms of cooperation are rather informal and not structured – often reactive, implemented as a response to requests coming from the academic world or from standards experts.

Only a few countries have developed a structured approach that combines various forms of cooperation, following a well-defined programme or an implementation plan. Those that do so, have implemented many of the forms of cooperation listed above and we have considered their experience to define a model of good practices for establishing and promoting cooperation between NSBs and universities.

Nevertheless, the feedback received from NSBs and the interactions during the workshops indicate that most countries, if not all, have the potential to move from an informal, reactive approach to a structured, well-planned development programme in this area which can lead to substantial progress.



### 3.4 Roadmap

This section provides a general description of the development path that can be taken to establish and nurture cooperation between an NSB and universities.

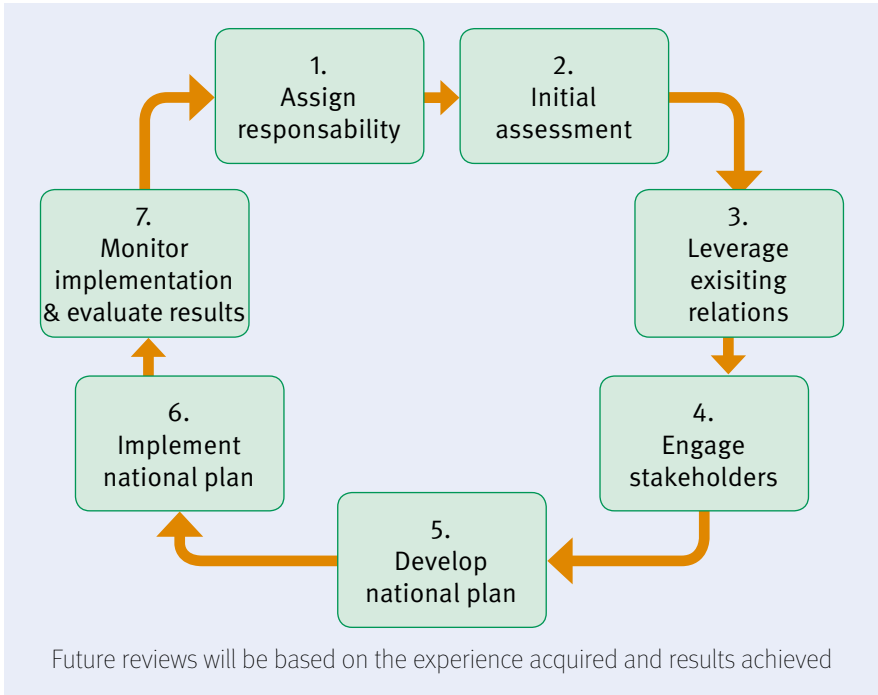
It is presented following a *bottom-up* approach, which matches the perspective of the vast majority of NSBs which participated in the ISO regional workshops in 2012 and 2013 – i.e. an approach based on building gradually from the existing situation, with the assumption that resources are quite limited and that there is no formal support (backed by funding) from public authorities.

We have, in particular, tried to follow the perspective of those countries that at present have limited or very limited relations and activities shared with universities, because they are the majority.

However, the concepts and the practices proposed in this roadmap can be usefully considered by countries having a more advanced level of cooperation – with the understanding that, depending on their specific situation, they can modify or just skip some of the described steps. This applies



also to the few countries that may find themselves in the position of pursuing a top-down approach, for example if they can benefit from government funded programmes aiming to boost standardization education in the country.



### Step 1: Assign responsibility

No matter how limited are the available resources (human and financial), it is imperative to identify a unit or a person within the NSB responsible for this type of activity. For most NSBs, this can be a part-time assignment for one or more persons – requiring, at least in the beginning, a small amount of time. However, it is essential to identify a specific responsibility in order to capture and manage in an organized way the information regarding the NSB’s relations and activities with universities.

## Step 2: Initial assessment

Begin with an assessment of the country's starting point – identifying and evaluating the existing forms of cooperation.

As already mentioned, all NSBs have the possibility to make an easy start, including those with very limited resources, episodic relations with universities and unlikely support from government.

You don't need to complete an accurate and comprehensive analysis (especially if the existing relations are rather limited). The key point is to build a map listing the existing relations with universities, academics and other relevant actors (**see box**).

This can be done rather quickly – possibly in one week or slightly more, depending on the available resources.

All the NSBs which participated in the ISO regional workshops in 2012 and 2013 should have already done this exercise – or, in any case, they are in a position to complete this step easily.

### Initial assessment

Each NSB should start with an initial assessment of their engagement with universities. Here is an example of typical information that needs to be collected and compiled.

#### Academics involved in standards development work

- List the academics (university professors, researchers, students in doctoral programmes, etc.) who participate in standards development work. Identify in which fields and in which TCs they are active

- ▶ Identify who, among the academics, covers standards matters (at least to a degree) in their university courses, or in other aspects of their work (e.g. research, consulting)
- ▶ Identify who, among the academics, are particularly interested in standardization and keen to promote it (based on their behaviour, enthusiasm demonstrated for the topic, leadership in committee work, etc.)

### **NSB senior management**

In several cases, the CEO or other senior managers of the NSB have personal or institutional relations with universities or stakeholders that could be particularly important for developing cooperation with universities. It is, therefore, very useful to map out the list of contacts that may concern:

- ▶ Institutional relations with universities (rectors, faculty deans, members of university/faculty boards, etc.)
- ▶ Relations with university professors and other academics
- ▶ Relations with central government officers who are potentially relevant (e.g. Ministry of Education, Ministry of Industry and Trade, of Consumer Affairs, etc.)
- ▶ Relations with local government officers who are potentially relevant (e.g. local administrations participating in university boards or other bodies linked to universities)

### **Review the existing forms of cooperation between the NSB and universities, using the list given under section 3.3 for guidance**

- ▶ List the universities with which some forms of cooperation exist
- ▶ List the forms of cooperation already in place, with as much detailed information as possible. For example: if the NSB provides guest lecturers to certain universities, you should note down: faculties and courses addressed; what subjects are covered by the NSB's lectures; how many lectures are given on an annual basis; what type of teaching materials are used, etc.

### Step 3: Leverage existing relations

Based on the assessment of the existing relations, a number of actions can be quickly planned and pursued, even before (or in parallel to) developing a structured action plan.

Most NSBs agree that an immediate line of action is *to encourage and support academics participating in standards development to take an active role*, e.g. by proposing lectures on standards-related topics that fit with university programmes they are involved in. If some of them already cover standards issues in their courses, they can be taken as examples and encouraged to share their knowledge and experience with colleagues inside and outside their university.

The *existing relations of the CEO or of other NSB senior managers with universities* are another important and straightforward element to cultivate and exploit. Often NSB senior managers have an academic background or, in their professional career, have had the opportunity to build relationships with universities. These links can be useful starting points to open doors, initiate a dialogue and consider initiatives of common interest.

More in general, the NSB should contact all the universities with which some relations exist, trying to establish a dialogue aiming to strengthen existing forms of cooperation or to set up new ones.

For many NSBs this will mean changing from an often passive approach, e.g. providing lectures on standards topics upon request, to a proactive approach, according to which interaction with universities should be conducted on a regular basis.

## Step 4: Stakeholder engagement

Initiatives aiming to communicate the importance of standardization education to various stakeholders can be set up and promoted at any stage of development of the NSB's efforts to build cooperation with universities. It is listed as “step four” in our ideal roadmap, because this activity is less *immediate* compared to leveraging existing relations.

Stakeholder engagement can be pursued in various ways: e.g. by organizing meetings and workshops targeting specific stakeholder groups (academics, students, university managers, representatives of government and industry); by promoting and encouraging the participation of academics in standards work; by cultivating high-level relations with academics, government and industry management and by trying to involve NSB representatives in the advisory boards of faculties, in national accreditation bodies, in teacher associations and other organizations that have an influence on university programmes and didactical activities.

Many NSBs consider relations with government stakeholders particularly important. These may concern the Ministry of Education and/or other ministries: such as the Ministry of the Economy, Industry and Trade, Mines, Agriculture, Health Care and others. Raising government awareness and support is considered critical by those countries where the government has a substantial influence in shaping industrial policies and the country's overall direction in education.

An important aspect for communicating with stakeholders is to present a clear description of the benefits of standards and justify the need for standardization education – following the arguments presented in section 1.2<sup>7)</sup>.

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7) Documentation developed at national level to support this position is the most effective. However, publications and other materials from ISO (e.g. those on the benefits of standards) or from other sources, including other NSBs, can also be effectively used.

Another important step that can mark the evolution of the NSB's ability to promote standardization education is to establish a dedicated national forum involving a plurality of stakeholders – some already exist, under the name of *CoE* (Committee on Education) or *CoSE* (Advocacy Committee on Standards in Education). Where established, these committees have proven to be a useful forum for discussing needs and requirements in this area; for organizing/promoting initiatives and for supporting communication efforts. Such forums should include academics involved in standards development (especially the most interested and active ones), representatives from industry and government that have some interest/sensitivity towards the matter and a coordinator from the NSB. Initially, this can be organized as a small informal group that, if needed, can later evolve to become a more structured/formalized body.

### **Step 5: Develop a national plan**

This is a fundamental step for all NSBs that intend to develop cooperation with universities in a systematic way.

It is recommended to start with the development of a **national strategy on education about standardization** – or with a definition of a specific section of the national standardization strategy dedicated to education (and, in particular, to university and other higher-level educational institutions).

The strategy on education can be a high-level document providing more or less detail on the subject. In any case, it should set out the key aspirations and objectives that the NSB intends to achieve in this area, the timeframes to accomplish them and the most important lines of action to be pursued.



“The SABS academic engagement programme was launched in March 2012 and since then we have travelled to several teaching

institutions speaking to leaders, refining the product offering and finding out more about the level of understanding of standards and the need to include standards in the curriculum. The main focus has been to target Engineering faculties. In January 2014, we began working with the University of South Africa (UNISA) School of Business Leadership (SBL) and a programme of cooperation is being developed between the SABS and the UNISA SBL to place standards and quality on the business school curriculum.”

### **Geoff Visser**

PhD., Research Fellow at South African Bureau of Standards (SABS)

The national strategy needs to be **complemented by an implementation (or action) plan**, which needs to cover the matter in detail, providing an operational framework for the actions to be undertaken and for monitoring and assessing the results achieved. The implementation plan can span one or more years, depending on the specific conditions and philosophy of each country – however, it is essential to maintain a short-term perspective to monitor partial results on a monthly/quarterly basis, following a continual improvement approach.

If a national forum dedicated to standardization education exists (and, as mentioned above, some NSBs have established *CoE* and *CoSE* groups) and involves a plurality of stakeholders, it must be involved in the development of the national strategy and implementation plan. This can also be an excellent opportunity to receive support and commitment from organizations and individuals for the actions to be undertaken.

The structure and content of these documents can vary considerably, depending on the characteristics of each country and NSB. In general terms, however, we recommend covering a number of key aspects, as outlined below – with the understanding that the scope of the plan and the level and complexity of its objectives (and proposed actions), must be commensurate to the experience already gained and to the resources available.

- Description of the current situation, i.e. how education about standardization is practiced in the universities<sup>8)</sup> (or other institutions of higher education) of the country. Indeed, except for very small countries, it would be almost impossible to provide an exhaustive picture of the national reality and, in most cases, the NSB will not be in a position to capture all this information. However, it is important to come out with an explicit picture of what is known (and plausible), along with a detailed list of the existing framework of activities and relationships involving the NSB (directly) or other entities linked to the NSB (technical bodies, associations, government agencies, etc.)
- Identification of the areas of highest priority for the country and for the NSB. These may concern typically: industry sectors (along with sub-sectors and technologies or practices of particular importance for them) and areas addressed by public policies – regarding, for example, economic development, consumer protection, public health, safety and environmental issues. This information should be complemented by

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8) A national strategy on standardization education is likely to consider education in general, covering a variety of levels – from primary school to vocational education. As already indicated, this guide focuses on higher education and that is why we make exclusive reference to it. However, NSBs can have implementation plans that describe specific objectives and actions regarding a plurality of education levels.





an analysis of the professional roles for which knowledge of standards issues is most required or desirable. *This is possibly the key point of connection between the national standardization strategy and the strategy on education about standardization*

- Identification of the institutions of higher education to be addressed and definition of priorities. This can be done using various criteria: by discipline (e.g. engineering, management, social sciences, etc.), level of education provided (undergraduate, graduate, etc.), location, reputation, possible links with stakeholder groups – and by considering to what extent their teaching matches the priority sectors or professional roles previously outlined. Clearly, those institutions with which relations already exist (as identified in previous steps of the roadmap, notably Step 2, *Initial*



“I have been engaged in standardization education for about seven years. My students include undergraduates, graduates and

on-the-job practitioners. I think that, despite its short history, standardization has expanded its application areas from the leading field of technical standards to service and public management. Standardization education needs to evolve and strengthen in accordance with these changes. Currently, most on-the-job practitioners have never received a specialized standardization education. So it is important and urgent to help them acquire specific knowledge and skills. New curricula need to meet their needs in the ways of in-service education and short-term training. Finally, public awareness of standards and standardization is relatively superficial. We need more efforts in popular science education to promote basic knowledge of standardization and to spread understanding of the role and benefits of standards.”

### **Zhou Lijun**

Associate Professor, China Jiliang University, Hangzhou, China

*assessment* and Step 3, *Leverage existing relations*) should constitute a core target for which more specific objectives/ actions can be defined

- Definition of the objectives of the plan. Some can be of a general nature (e.g. *raise awareness of the importance of standardization education* or similar), but it is highly recommended to set, as much as possible, concrete and measurable targets. Ideally, it is desirable to set key objectives concerning ultimate outcomes : e.g. number of universities having introduced education about standardization (through new courses or in other forms); number of students educated ; materials developed by the NSB and used by universities, etc. However, it can also be practical and useful to set targets with regard to : intermediate objectives concerning, for example, communication activities, stakeholder engagement and other aspects
- Identification and allocation of the resources (existing or to be acquired), both financial and human, needed to support the implementation plan. This is clearly a very important aspect and a specific analysis should be dedicated to considering the possible sources of funding – additional considerations on this point are given in the box highlighting some of the key issues to be addressed by NSBs
- Definition of the actions to be undertaken. These will usually be related to the forms of cooperation listed under section 3.3. It is recommended to develop and manage a specific list recording all the action items planned in the timeframe covered by the implementation plan (*a simplified example is given in the box below*). The importance and complexity of the actions will certainly vary : the most significant ones should be considered and managed as specific projects

- Assignment of specific responsibilities and tasks to NSB staff. Dedicated staff – at least one person to coordinate the NSB’s implementation plan on education – is desirable, but this may not always be affordable. In any case, it is strongly recommended to appoint an overall coordinator for the NSB’s activities promoting cooperation, even if this role is performed on a part-time basis. In addition, the responsibility of each specific action in the plan needs to be unambiguously assigned to an NSB staff member
- Consideration of forms of cooperation at bilateral, regional and international levels that can help to identify common needs, leverage/share resources (e.g. training materials and lecturers), projects and potential sources of funding (e.g. donor agencies). There is much room for cooperation among NSBs (within the same region, as well as with those from countries that are important partners), with regional and sub-regional organizations as well as with ISO
- The implementation plan should include specific performance indicators allowing the measurement of results achieved – they can be defined quantifying the expected outcome of a selection of action items included in the plan: usually those that will help to assess if, and how much, progress is made against the objectives of the strategic plan

## Example of simplified action item lists

### 1. Communication

#### 1.1. Conferences or other events to promote standardization education

Where	When	Theme and structure of the event	Key partners	Responsible person
...				
...				

#### 1.2. Visits

University	When	Who	Issues/Proposals	Responsible person
...				
...				

#### 1.3 News/publications

Medium	When	Primary target	Content	Responsible person
...				
...				

### 2. University courses

#### 2.1. Teaching materials

University/Faculty	When	Subject matter	Author(s)	Responsible person
...				
...				

#### 2.2. Guest Lectures

University/Faculty	When	Subject matter	Lecturer(s)	Responsible person
...				
...				

#### 2.3 Workshops (targeting students of one or more courses/disciplines)

University/Faculties	When	Theme	Speakers	Responsible person
...				
...				

## Some key issues

### Meeting market needs

Even if the plan identifies national priorities with regard to industries, practices and others, it is important to recall that each individual university operates in a specific context (often rather local), and that it serves a unique combination of interests and communities, which is continuously evolving. It is, therefore, of vital importance to understand this context and to find ways to collaborate with the university's organizational entities (such as faculty boards) that are primarily involved in this type of analysis, with a view to identifying what are the needs and what type of standardization education is best suited to serve them.

### Funding

There are typically three main sources of funding that NSBs can seek to support their plans on standardization education: government, the private sector and donor agencies.

The relative importance and possibility to access these sources vary greatly, depending on the level of development and on the specific conditions of each country.

In general terms, we can say that funding from the private sector is potentially more significant for developed countries; donor agencies concern primarily developing countries and government is relevant to both. In what follows, we shall discuss briefly government and donor agencies – with the understanding that these are only general recommendations and that each NSB should consider carefully the conditions of its own country.

### Government

Four essential conditions should be observed:

- ▶ Proposals regarding standardization education should fit well with existing government priorities and plans with regard to national education. Please note that introducing standardization education can be very well presented as a measure contributing to improving the labour-market

relevance of education, which is often an important objective of national education strategies

- ▶ Proposals need to be well structured, describing why and how they fit into national priorities; what are the expected outcomes and impacts on such priorities, and how progress can be monitored on a regular basis
- ▶ Support from universities (i.e. joint proposals) and from stakeholder groups will contribute to making a stronger case
- ▶ Proposals need to target areas that are included in the budget of the concerned Ministry/Agency
- ▶ The existence of relationships with senior government officers (e.g. through the NSB's senior management) will of course facilitate interactions.

### Donor agencies

A large number of donor agencies<sup>1)</sup> target education – including government agencies, regional groupings, multilateral agencies and private voluntary organizations (or non-governmental organizations). Even if insufficient financing, particularly by aid donors, is one of the main obstacles to achieving UNESCO's Education for All (EFA) goals set for 2015, the amount of donor funding for education is considerable – according to the UNESCO EFA Global Monitoring Report 2013/4, total aid to education disbursement in 2011 was USD 13.4 billion, of which 5.4 was dedicated to post-secondary education.

Beyond basic education, demand for tertiary education and for technical and vocational education and training (TVET) is growing in every region – along with funded TVET projects. Improving the labour-market relevance of education is, in fact, an important objective of governments and donor agencies. Many young people in developing countries are leaving school and entering the labour market without the knowledge, skills, and competencies necessary for employment in a competitive modern economy: this is an area of significant concern that needs to be addressed.

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1) Some national agencies, the European Union, the World Bank, UNESCO and GPE (Global Partnership for Education – a multilateral agency comprised of close to 60 developing countries, donor governments, international organizations, the private sector, teachers, and civil society/NGO groups) lead the efforts in this domain.

This is precisely the context where education about standardization can fit well: as one of the instruments that can help to build skills and competencies required by the market (and modern public administrations as well).

Given the higher cost of TVET education services, cost-effectiveness and returns on investments are principal concerns. Credible projects targeting donor agencies in this area need to be well defined and provide clear indicators to measure cost-effectiveness and outcomes.

However, this is a complex and highly competitive domain: there are many requests for donor money. The development of a successful strategy to identify potential donors is critical in the process of securing funding. In general terms, it is recommended to undertake the following steps:

- ▶ First, a list must be compiled of funding agencies likely to become interested in your project/programme and its aims
- ▶ In order to do so, you can search on the Internet, starting from the main agencies involved in this field (such as UNESCO, the World Bank, GPE, national agencies, etc.) and identify various initiatives or organizations that they sponsor. Another approach is to contact and collect information from institutions of donor countries with which the NSB (or other organizations connected with the NSB) already maintain contacts, or directly contact embassies or other relevant offices of prospective donor countries
- ▶ It is also useful to exchange information with other NSBs, particularly from the same region, and to regularly monitor calls for proposals or papers issued by potential donor agencies
- ▶ It is helpful to develop a filing system in which you can index and archive information about relevant funding agencies. This system should be consistently updated and consulted whenever needed. The task should be assigned to a specific person, involved in the team covering education about standardization – although this responsibility can be shared with other units, possibly with a view to maintaining consistent information on donor agencies that can support the NSB's projects in various fields



## Cooperation

Cooperation between NSBs and universities at regional and international levels is considered very important and helpful.

Regional and international cooperation brings value in terms of:

- ▶ Exchange of information and experiences, allowing NSBs and universities to take advantage of ideas and approaches followed in other countries
- ▶ Development and sharing of teaching materials
- ▶ Development of extended, across-the-border, pools of experts
- ▶ Helping to enrich national events and initiatives bringing an international dimension
- ▶ Facilitating the establishment of university networks (providing additional opportunities for students and academicians and increasing the attractiveness and status of education about standardization in universities)

## Rewarding and assisting professors

Professors have a critical role to play in introducing and promoting standardization education and they need to be supported in the best possible way.

The experience of some NSBs indicates that:

- ▶ It is important to recognize the **personal contribution** of professors and to reward their commitment and enthusiasm (whenever possible, this may involve limited financial contributions – for example, to cover travel costs to participate in relevant events – as well as other forms of recognition, such as awards)
- ▶ NSBs should provide easy access to existing resources (teaching materials, pool of experts, support student visits, etc.)
- ▶ Professors should be helped in adopting effective approaches to promote standards-related topics in university courses. Examples are:
  - › Proposing “soft” entries (i.e. lectures that do not impact university curricula, but provide the opportunity to enrich existing courses)
  - › With minimum cost (ideally zero-cost for the university, with efforts that can be just shared by professors themselves and the NSB)

- ▶ Emphasizing the benefits for the university (e.g. helping to make courses more attractive to students, to receive company and/or government recognition and support)

### Encouraging students

Students are, in the end, those who determine the success or failure of university courses. To meet the needs of students, the following lines of action are recommended:

- ▶ Identify **job opportunities** and highlight how knowledge about standardization may help to seize them
- ▶ Capture and nurture the **attention and motivation of students** – for example, through high-quality content, innovative ways of teaching, etc.
- ▶ Always **consider the student's perspective** (usefulness and attractiveness of courses, difficulties, support, etc.) and monitor students' attitude
- ▶ Reward students' commitment and performance (for example, through student competitions and awards)

## Step 6: Implement the national plan

The actions included in the implementation plan have then to be translated into practice. This mostly requires an understanding of the specific conditions in which each NSB operates. From a general standpoint, we would like to give three key recommendations:

- Provide good arguments with regard to the benefits that standardization education can bring to universities. Direct, immediate benefits are of course the most attractive: for example, specific actions supported by government or other entities (including those from the private sector) that call for the development of courses or programmes involving standardization

and comprising funding or other types of support. Explicit requests from stakeholders (e.g. industry and government) indicating their commitment/willingness to provide jobs to students with qualifications in standardization, can also be quite effective. And, in general terms, the prospect of job opportunities (or of increasing the students' qualifications and attractiveness for specific jobs) is a key driver for universities' motivations – the more elements that can be presented to justify this assumption, the better (including for example, analysis of the job market, indications from companies and public administrations, etc.)

- Be systematic and effective. The success of the implementation depends substantially on the ability to target this area with continuity and determination. Most often, it takes a significant time to build relations and develop even simple forms of cooperation with universities, and more effort to maintain and expand them. Never forget that university curricula represent a fierce competitive landscape: there is a lot of pressure to introduce new and different topics, advocated by a variety of pressure groups
- Involve people with enthusiasm and passion for the subject. They can be professors significantly and positively involved in standards development, standards users (from industry or government) who can highlight how they use standards and why standards are important to them, NSB employees who are genuinely interested in standardization and are talented in interpersonal relations and teaching, etc.

Another important aspect that has been underlined by NSBs with a specific experience in implementing a national plan, concerns the **formalization of agreements**

– especially when a certain level of cooperation has already been established.

Formal documents signed by both parties, such as *Memoranda of Understanding or Cooperation Agreements* between NSBs and universities are considered the most appropriate framework because they allow for clearly defining :

- Who does what (scope and activities of the cooperation and related responsibilities)
- Who pays for what (terms of financial commitments/ responsibilities regarding the activities covered by the agreement)
- Legal responsibility (regarding activities, intellectual property and other aspects)

Formalized agreements help to ensure sustained commitment from both parties and allow easier monitoring and reporting.



“ Standards education in Indonesian universities was first introduced in 2005. As of 2014, BSN has signed MoUs with 31

universities to develop and run courses covering standardization. At present, we are revising standardization textbooks and are close to introducing our second editions for higher education. Based on the success stories from the undergraduate students who took standardization courses, it is evident that competencies in standardization are very useful in supporting their career and jobs – in Government, Industry and the national standards body. Competencies in standardization can also stimulate their interest in continuing graduate level studies.”

**Mrs. Dewi Odjar Ratna Komala**

Deputy Director General for Information and Socialization on Standardization, BSN (National Standards Body of Indonesia)

## Step 7: Monitor implementation and evaluate results

As previously indicated, the plan should include specific *performance indicators* allowing to measure the results achieved.

In this context :

- **Monitoring** means : the systematic collection of data on the specified indicators to provide management and the main stakeholders with indications as to the extent of progress and achievement of objectives
- **Evaluation** is : the systematic and objective assessment of an ongoing or completed project or programme, including its design, implementation and results. The aim is to determine the relevance and fulfillment of objectives along with the efficiency and effectiveness of the implementation

We recommend monitoring the execution of the plan on a regular basis : depending on the scope, structure and complexity, monitoring can be performed on a monthly or quarterly basis (keeping some formal recording of data – even if very simple).

Evaluations of the whole programme or of some of the most significant actions and projects, can be performed on an annual basis – or on shorter timeframes if there are particular needs (e.g. meetings of stakeholders, submission of proposals to potential funders, etc.).

The annual evaluation of the implementation plan – including, if needed, a more detailed analysis of the most important projects/actions – will be used to develop or to improve and update the implementation plan for the following year.

### 3.5 A long-term, structured approach to standards education with high impact

The example of the Republic of Korea's<sup>9)</sup> University Education Promotion on Standardization (UEPS) programmes

#### Background

Similarly to other recently industrialized countries and emerging economies, the Republic of Korea (hereafter, Korea) has followed a top-down, government-led approach to national development and innovation. Korea's efforts in standards education are aligned with this top-down approach and can be characterized as an outcome of public sector leadership.

The rapid path of development of Korea has been driven by export-oriented industrialization and participation in the global market, for which the role of highly skilled human resources has been key. Human resources development has been a national priority for decades and, today, the proportion of Korea's population with tertiary education is one of the highest in the world (OECD 2011).

Recognizing the increasing importance of technical standards and standardization in globalization and technical trade, the Korean government decided to address systematically the issue of education about standardization in the late 1990s. In 1999, the Government of Korea enacted the 'Framework Act on National Standards', which provides the basic requirements for the national standards

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9) The information presented in this section is based on materials delivered by KATS and KSA at the ISO regional workshops and by **Dong Geun Choi** and **Henk J. de Vries**, *Integrating standardization into engineering education: the case of forerunner Korea*, International Journal of Technology and Design Education, November 2013, Volume 23, Issue 4, pp 1111-1126, Springer Netherlands.

system of Korea – defining, *inter alia*, the responsibilities among Korean government ministries on matters relating to standards; the harmonization of various types of Korean standards and technical regulations with International Standards; the establishment of a conformity assessment system for the operation of testing/calibration laboratories and inspection/certification bodies.

The National Standards Act requires the Korean government to set up a Korean National Standards Plan (KNSP) every five years. The Korean standards education initiative was launched in the framework of the first KNSP 2001-2005, confirmed and strengthened in the period covered by the second KNSP 2006-2010, and further extended in the framework of the third KNSP 2011-2015.



“I believe standards and patents are the two most important pillars of industry innovation. However, the education about

standardization is much weaker than that for patents. The standards community needs to set up plans and work hard to make education about standardization comparable to education about patents.”

### **Donggeun Choi**

PhD., Chief Researcher, International Standards Team, Korean Standards Association (KSA)

### **The Korean standards education initiative**

More specifically, the first KNSP 2001-2005 highlighted the importance of the *systematic development of human resources for national and international standards activities*. The second KNSP 2006-2010 specified the need for action with regard to standardization education, precisely through its section 4.3, “Training standards experts and building an expert network” and section 4.4, “Increasing awareness about standardization and strengthening promotion

and education activities.” The third KNSP 2011-2015 reaffirmed the importance of human resources and addressed the issue of standards education in further detail, indicating quantitative targets to be achieved.

In planning and implementing the three series of KNSPs and the related standards education activities in Korea, two organizations: KATS (Korean Agency for Technology and Standards) and KSA (Korean Standards Association), have played key roles.

KATS is a government agency, under the auspices of the Ministry of Trade, Industry and Energy (MOTIE)<sup>10)</sup>, whose key mission includes national standards, conformity assessment, accreditation, national membership in ISO and IEC, product safety management, legal metrology, and management of the WTO/TBT inquiry point ([www.kats.go.kr](http://www.kats.go.kr)). KSA is a non-profit and non-governmental organization, a so-called public organization in Korea, and its scope encompasses standards development, KS/ISO/JIS certifications, quality control and management, and education/training services ([www.ksa.or.kr](http://www.ksa.or.kr)).



“ Standards impact not only the operational level but also the strategic level in businesses. Information systems established

at the operational level can be used strategically by companies to generate competitive advantage. The same applies to standards. This is why, I think, standards education needs to be included in business schools as well as in engineering schools.”

**Byunggoo Kang**

Professor, Korea University

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10) MOTIE was formerly named the Ministry of Commerce, Industry and Energy (MOCIE) in 1998-2008, and Ministry of Knowledge Economy (MKE) in 2008-2013.



The standards education initiative, led by KATS and KSA, has followed five major steps :

1. Set-up of a national strategy on education about standardization
2. Development of a long-term plan, supported by a significant and stable source of funding
3. Assignment of the overall responsibility for implementing the plan to KSA
4. Cooperative network building with the education community
5. Continuous improvement of the programme and innovation

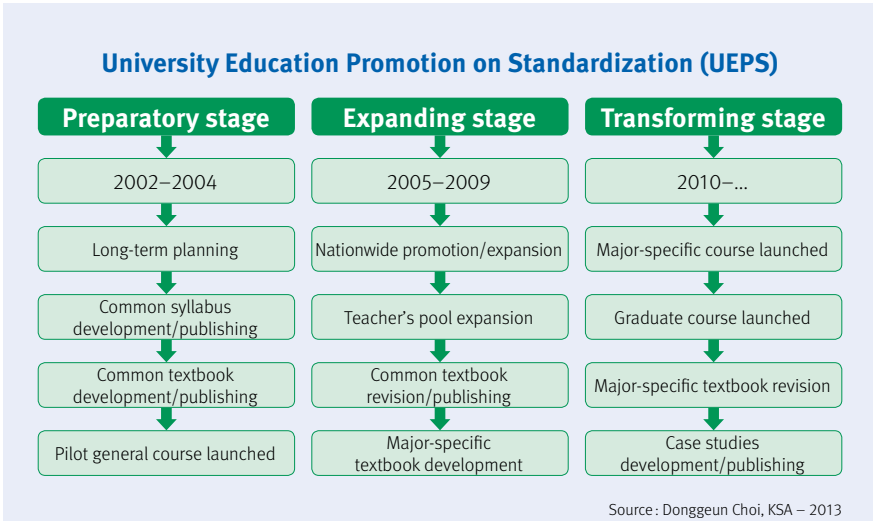
Although there was no specific reference to university education in the first KNSP 2001-2005, the planning teams in KATS and KSA, drawing from recommendations from the Korean standards expert community, developed the conceptual details of the **University Education Promotion on Standardization (UEPS)** programme in a project proposal in 2002 and started its implementation in 2003.

Subsequently, KATS and KSA developed a long-term plan named **Life-long Standards Education**, covering education on standardization for all educational levels, including primary schools, secondary education (particularly through the *Standards Olympiad* for teenagers), the university education programme and the training programme for industry. The implementation of the programmes targeting primary and secondary schools started in the framework of the second KNSP 2006-2010.

In what follows, coherently with the scope of this publication, we consider only the UEPS programme – information on the programmes targeting primary and secondary education can be found in the proceedings of the ISO regional workshops organized in 2012 and 2013 and on the KSA’s web site.

## The University Education Promotion on Standardization (UEPS) programme

The various phases of development and evolution of the UEPS are highlighted in the figure below.



The initial programme, coordinated by the KSA, was focused on **undergraduate engineering schools** and consisted in the development and dissemination of a basic course on standardization based on a common syllabus and dedicated textbook (*Future society and standards*), which could fit into a broad variety of curricula. The KSA developed additional teaching materials (Powerpoint presentations and reading materials), organized a pool of experts capable of providing guest lectures, and offered field trip opportunities for students.

The course was designed with a significant degree of flexibility, allowing professors in different institutes and disciplines to customize the course on the basis of their specific needs. Courses offered through the UEPS programme

covered one semester class (for a total of 32 to 48 lecture hours, corresponding to 2 to 3 Korean credits) and could be made mandatory or elective, depending on the curriculum in which they fitted.

Most importantly, along with an extended “package” of deliverables (syllabus, textbook, teaching materials, teaching manual, access to the pool of expert lecturers, field trip opportunities), the KSA was also able to provide limited funding to each participating university – used to cover direct costs (e.g. guest lecturer expenditure, student field trips, scholarships for teaching assistants).

The first year implementation in 2004 was successfully joined by 11 universities and 982 students. Following this promising start, the programme was then consolidated and expanded. Since 2005, annual government **funding ranging between USD 5 and 8 million** allowed the KSA to allocate full-time staff to the project, to invest in revising



and improving the textbook, to develop new publications, to expand the expert network and to organize events.

The UEPS programme has been coordinated by a steering committee comprised of around 10 key representatives from university, industry and standards-related organizations. It meets several times a year and provides strategic advice and recommendations to the KSA about planning and operating the UEPS, such as for textbook development and university outreach.

As from 2010, the UEPS started to diversify its approach. Until 2009, all the UEPS courses were based on the common and cross-disciplined textbook, *Future Society and Standards*. In addition to that, **four specific textbooks** were developed, covering standardization in information technology, mechanical engineering, electrical/electronic engineering, and environmental engineering.

In 2010, eight major-specific UEPS courses were launched, including two graduate school programmes – in information technology and electrical/electronic engineering. In 2011, 13 major-specific UEPS courses opened, including four graduate programmes. In addition, new courses for standards and intellectual property rights and architecture engineering and standards were developed and operated independently in two graduate schools.

### Evaluation and challenges for the future

The UEPS programme has proved very successful and is recognized worldwide as a key reference. Between 2004 and 2011, the UEPS programme has generated, on an annual basis, **between 64 and 96 courses**, adopted by 40 to 50 universities and followed by a number of students, varying between 4 000 and 7 000.

In total, in the period 2002-2011, **6 044 UEPS courses were delivered to 38 054 students**. These courses were delivered

in 59 four-year universities, representing 27% of the 222 four-year universities in Korea, and one three-year college.

The key challenge for the future concerns the long-term sustainability of the programme. This is an issue for any government-funded programme: what if the government stops funding it?

Under the UEPS, the KSA provides small grants to the participating universities on a three-year agreement basis and the sustainability of the programme emerged as a critical issue at the end of the first cycle of funding, in 2007. Even if KATS and KSA have encouraged universities and professors to continue the courses after the funding stops, this was not always easy.

Universities are required to manage the total number of courses and courses funded from outside are more carefully screened for continuity after the funding stops. Funding expiration of the UEPS limits the opportunity to invite guest lecturers, and this requires the professors to cover more classes themselves – dealing with subjects that external guest lecturers had covered in the past.

Although not all universities continued, self-funded UEPS programmes have increased gradually since 2009 in different ways. Some universities continued with a smaller number of guest lecturers; some modified the syllabus, allowing internal professors to cover most classes; and others invited standards experts as lecturers for the whole course. The KSA has supported free textbooks and provided guest lecturers on an on-demand basis, budget permitting.

In any case, it is clear that the interest and engagement of professors is probably the most critical factor to ensure the long-term sustainability of the programme. The developments of the last few years are encouraging, and the KSA is committed to supporting the transfer of knowledge to university professors in various ways.

## 3.6 Obstacles and key success factors

### 3.6.1 Obstacles

Several obstacles to the development of cooperation between NSBs and universities were identified and discussed during the regional workshops.

The most important ones are indicated below:

- Standardization education is often not recognized/ considered a priority<sup>11)</sup> by NSBs and the majority do not have staff members who can be dedicated to developing and supporting relations with universities
- The importance of the relation between standards and education is often not recognized by stakeholder groups (including governments)
- NSBs lack financial resources to support programmes/ initiatives targeting universities
- Universities are often not interested (or have a very limited interest) in standardization
- Substantial competition to including new subjects into university curricula – standardization is no exception and it is seldom considered a priority
- Lack of government support
- Lack of suitable teaching materials
- Limited availability of experts (from industry or NSBs, to contribute to standards-related programmes)
- Limited availability of professors/researchers interested and able to drive standards-related programmes

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11) This perspective is **rapidly changing**. We have already witnessed in the period 2011-2013 a significant change of attitude and the level of awareness of the importance of standardization education within NSBs is continuously rising.

Depending on the various country conditions and the NSBs' experiences, these obstacles can be more or less severe – they need to be considered seriously in the planning as well as in the implementation phases.

However, there was almost unanimous agreement among the participants in the ISO regional workshops that all NSBs have the possibility to overcome these obstacles effectively and to make progress in establishing or expanding cooperation with universities.

To succeed, the most important aspects are to set objectives commensurate to the resources and capabilities of the NSB and to pursue them in a gradual but systematic way. The roadmap presented in the section 3.4 has been designed precisely with this in mind.

### 3.6.2 Key success factors

Two aspects were identified as the most critical for the development of cooperation between NSBs and universities:

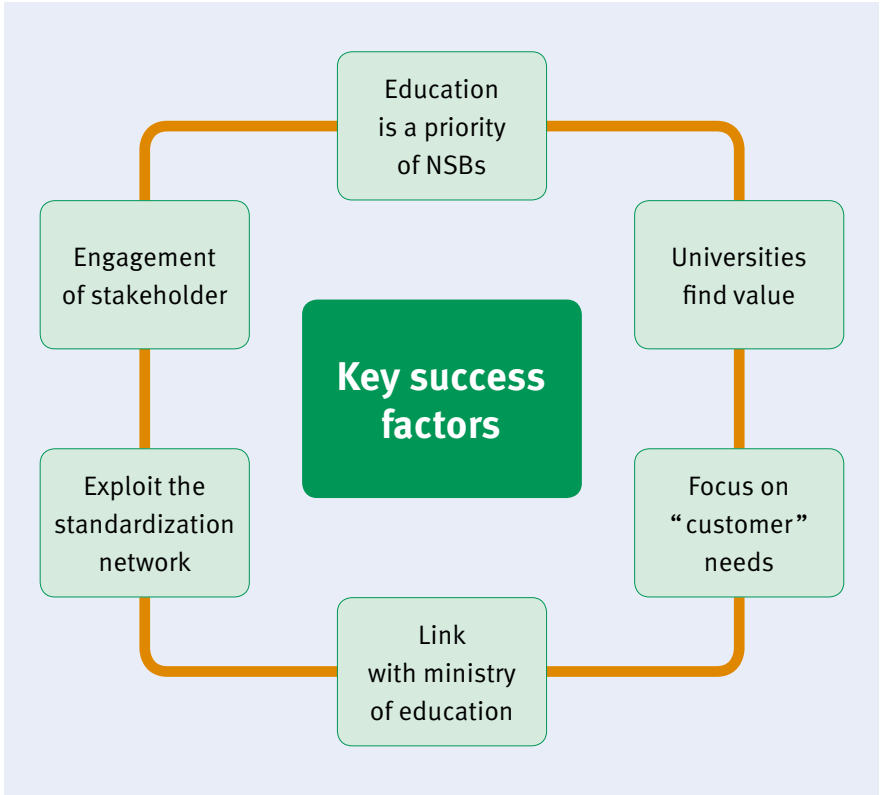
- NSBs need to consider the relation between standards and education a **priority issue** and act accordingly – better if this is explicitly stated in the framework of the national standards strategy, as indicated in step five under section 3.4 (a line of action concerning standards and education needs, therefore, to be associated with specific responsibilities and supported by dedicated resources)
- Universities need to **find value** in educational activities involving standardization – and NSBs might dedicate significant efforts to raising awareness of the importance of standardization and to convincing universities that this is the case

The other key success factors identified by the participants of the workshops concern :

- The identification of specific areas (related to professions and functions within organizations) where there are significant needs or potential interests for standards education. Markets and communities served by universities need to be analyzed, existing or potential *customers* of universities (i.e. providers of jobs for students) need to be involved and universities need to be engaged in the dialogue
- The development of a strong link with the ministry of education of the country (and possibly with other relevant government entities, e.g. ministries of industry and trade or other agencies), with a view to gaining support from them – if not in financial terms, at least in terms of endorsement or patronage of initiatives and programmes promoted by the NSB in this field
- The engagement of stakeholder groups, getting their input and support. Particularly important is the support from organizations that sit on faculty boards and companies that are potential employers of university graduates
- The ability to exploit the standards community network (access to experts, stakeholder groups and international connections)

Funding has not been listed among the key success factors on purpose, to underline that it is not indispensable and that a successful strategy can be pursued even with very limited resources. Indeed, the availability of funding would allow the setting of more ambitious objectives and extending the scope of activities concerning standardization education.





## 4 Quick wins

In previous sections we have underlined the fact that any NSB can make useful and important progress in developing and promoting cooperation with universities, no matter how limited are the available resources or the relations already existing with universities. The roadmap described in **section 3.4** has been designed with this in mind.

In addition, participants in the regional workshops have identified a list of possible “quick wins”: actions that can be immediately pursued by the actors interested in developing cooperation between NSBs and universities. The list of these actions concerning both academics and NSB staff, is outlined below.



Academics interested in standards education (especially those already active in standards work, e.g. in technical committees) can :

- Start to give lectures (if they don't do this already) on standards-related issues within their courses
- Invite guest lecturers (from NSBs, from industry, etc.) to cover standards-related topics in their courses
- Identify in which areas standards (or additional knowledge of standards and standardization) are relevant to their discipline
- Share these views with colleagues and promote the adoption of similar practices
- Establish/maintain relations with the NSB (regular exchange of information, request for materials, information, access to qualified experts, etc.)

Representatives of NSBs who have an interest in developing cooperation with universities (in particular, those who have attended the regional workshops) can :

- Report to and seek commitment from the NSB top management to define/drive a programme on standards in education
- Contact professors involved in standards development and/or other academics known to them or to the NSB management to open a dialogue
- Prepare concrete proposals regarding the simplest forms of cooperation (guest lectures, access to standards documents, visits)
- Look forward to including standards education in their national standardization plan
- Start to develop an action plan
- Open a forum for dialogue (with a view to creating an advisory committee on standards and education)
- Propose/launch school/university competitions, to raise awareness among students and professors

## 5 Moving forward – recommendations to NSBs and ISO

Today, the theme of *Education about Standardization* is very important for national standards bodies and, in some countries, it is already recognized as a priority.

The ISO regional workshops organized in 2012 and 2013 were considered timely and useful by all the NSBs which participated. More workshops will be organized after the publication of this guide, to enlarge the number of ISO members benefiting from a focused exchange of information on standardization education.

These initiatives allow to focus attention on the subject and give the opportunity to better address this important issue in many ways, for example by making use of information obtained and shared during the workshops, of the information resources presented and discussed and of the personal relations established during the workshop.

A number of recommendations have been collected so far regarding the way forward – new challenges and actions to be followed by NSBs and ISO in this domain. They have been summarized and reported below:

1. Follow-up and feed-back structure. Participants in the workshops believe it is important to keep in touch and to update each other on progress made in this area. ISO should consider ways to support this exchange of information and to record/evaluate progress made by NSBs
2. Clear description of the benefits of standards and of the need and value of education about standardization. A specific overview has been provided in





**section 1** of this document and many information and communication materials on the benefits of standards are available from ISO (**see section 6**, Information resources). Additional communication material can be developed by NSBs and ISO, considering the perspectives of academics, stakeholders and standards professionals, and highlighting case studies and success stories

3. Guidelines on how to provide access to standards for learning purposes. Today, ISO members are following different approaches, in most cases decided in isolation. An ISO guiding document on the subject would be welcome; describing criteria and mechanisms to be followed that a) would allow optimal dissemination of standards content for didactical use, b) would be in compliance with ISO's copyright rules and without harming ISO and NSB business models
4. The exchange of information and cooperation aiming to connect national/regional/international awards and competitions targeting standards education would be very useful to establish synergies and build critical mass, increasing the awareness and outreach of such initiatives
5. Extension of the ISO repositories (and of similar national/regional information sources), to gather and share

information on university curricula, courses and teaching materials on standardization available from all the countries

6. Information and guidelines on possible sources of funding. Some information has been given in **section 3.4** (box under step 5). NSBs and ISO can cooperate to develop more detailed guidance, describing potential sources of funding (in particular donor agencies and international cooperation/development programmes) and approaches that NSBs and universities can follow to address them
7. Identify mechanisms (access to funding, opportunities for publication, etc.) to promote and support research in standards-related subject matters – which can be an important driver for building universities’ interest and engagement
8. The possibility of establishing an ISO “committee on education” (an ISO interest group on the subject) should be investigated. This would allow to set up a network of people within each ISO member having specific interest in, and commitment to, standards and education. This would help to establish connections and further support the exchange of information, experiences and the development of common initiatives

## 6 Information resources

### 6.1 ISO information resources

ISO has developed a wide range of information resources covering the subjects of standardization education and of the value of standards – they are referenced here.

#### ISO Materials

[www.iso.org/iso/home/standards/benefitsofstandards/benefits\\_of\\_standards.htm](http://www.iso.org/iso/home/standards/benefitsofstandards/benefits_of_standards.htm)

Extensive information on the benefits that standards bring to organizations and, more in general, to citizens and society. It includes an overview (ISO standards – What’s the bottom line), a description of the approach developed by ISO to assess the economic and social benefits of standards (the ISO Methodology), fact sheets and full company case studies from over 20 countries, video clips, books and communication materials designed for sharing with decision makers and stakeholder representatives.

#### Studies on benefits of standards

[www.iso.org/iso/home/standards/benefitsofstandards/benefits\\_repository.htm?type=EBS-MS](http://www.iso.org/iso/home/standards/benefitsofstandards/benefits_repository.htm?type=EBS-MS)

Information on studies on the economic and social benefits of standards for trade, national economies, industry sectors, individual companies and citizens. These studies have been undertaken by different authors, such as national and international standards bodies, research institutes, universities and other international agencies

## Education portal

[www.iso.org/iso/home/standards/standards-in-education.htm](http://www.iso.org/iso/home/standards/standards-in-education.htm)

This section of the ISO web site provides access to all the information resources developed by ISO with regard to education about standardization – including those listed below.

## ISO repository of teaching materials

[www.iso.org/iso/home/standards/standards-in-education/education\\_materials-higher-edu.htm](http://www.iso.org/iso/home/standards/standards-in-education/education_materials-higher-edu.htm)

Lists existing teaching materials on standardization, with details of the authors and publishers. Teachers and standards professionals can use this tool to access information that can help them in designing and delivering courses on standards matters. This repository can facilitate the re-use of existing materials and highlight new subject matters to be addressed in the future.



## **ISO repository of standards and innovation**

[www.iso.org/iso/home/standards/standards-in-education/education\\_innovation-list.htm](http://www.iso.org/iso/home/standards/standards-in-education/education_innovation-list.htm)

Contains bibliographic information on articles, policy documents and academic research about standards, innovation and related issues : such as standards and research and development, intellectual property rights, standards and innovation policies, standards and innovation in business strategy, etc. Links to the full text are available in some instances. This material can be used for educational purposes as well as for research.

## **University of Geneva Masters' programme on Standardization, Social Regulation and Sustainable Development**

[isotc.iso.org/livelink/livelink?func=ll&objId=15724341&objAction=browse&viewType=1](http://isotc.iso.org/livelink/livelink?func=ll&objId=15724341&objAction=browse&viewType=1)

All teaching materials developed by ISO for this programme are available to the ISO members and to universities interested in partnering with them (please note that this is a password protected site).

Additional information from the University of Geneva web site is available here : Master on Standardization, Social Regulation and Sustainable Development.

## 6.2 Other information resources

References to information resources available from other organizations – such as national standards bodies, regional and international organizations – are given through the ISO web sites listed above.

Here are listed just two regional information resources, which provide access to materials and references to other resources.

### Asia/Pacific : APEC Standards Education Initiative

[www.wisestandard.org/](http://www.wisestandard.org/)

### Europe : Education and training on standardization

[www.cencenelec.eu/standards/Education/Pages/default.aspx](http://www.cencenelec.eu/standards/Education/Pages/default.aspx)



“Standards are not meant to be a static limitation for activity or creativity, but should function as a dynamic foundation for improvement

and innovation. Years ago I learned this lesson at the Rotterdam School of Management, Erasmus University, but it is still an actual and valuable insight in my current role.”

#### Roes Haverkamp

Director European Quality, Environment, Safety & Health (QESH) at Interface European Manufacturing in Scherpenzeel, The Netherlands



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