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# WHITE PAPER

# ACADEMIC STANDARDISATION EDUCATION IN EUROPE

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**Preface**

We take pleasure in presenting a White Paper on standardisation education. This White Paper has been prepared on behalf of EURAS. In the EURAS Membership Meeting Friday 2 July 2010, Lausanne, Wilfried Hesser proposed the development of a White Paper on Standardisation Education. Following a discussion, the members of the EURAS approved the proposal. W. Hesser and H. de Vries were responsible and prepared a draft document. Our thanks go to Dr Axel Czaya and Dr Nicole Riemer for their assistance in preparing this document. The draft was approved at the EURAS membership meeting in Kaunas, Lithuania, Friday 10 June 2011. We thank all EURAS members and others who provided comments on this draft. We sincerely hope that this White Paper will contribute to better and more academic education on standardisation in Europe, for the benefit of society as a whole, companies and other stakeholders.

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**Preface**

# I    ABSTRACT

Standardisation is a strategic asset at the level of companies, industry sectors, countries and regions. To excel in standardisation, proper education is needed. This is well understood in several Asian countries, where they are increasingly implementing standardisation education programmes. Europe is lagging behind. The governments of the member countries of the Asia Pacific Economic Cooperation (APEC) have decided to implement standardisation education in their countries 2006 – 2010. Such a decision has not yet been taken at the European level, although there is recognition of the importance of the topic. In Europe there is a great discrepancy between policy and practice. It is the official policy of the EC and European Parliament to promote the European standardisation system, of which it has high expectations. However, current practice shows no more than fragmented standardisation education activities in the EU and hardly any programmes at the academic level.
This White Paper addresses this issue. It proposes European initiatives to escape from the present situation of only some fragmented initiatives. A common European strategy is needed and support from Europe to get education implemented at the national level. This paper details measures to be taken at the European level.

To make this possible, a European Standardisation Education Agency is needed. A small group of staff should carry out the necessary activities or coordinate activities that are outsourced to experts within and outside universities in the member states. This agency needs a steering group at the European level in which member countries as well as a variety of European stakeholders are represented. At the national level there should be parallel structures.

# II    RECOMMENDATIONS

Asian countries are presently leading the way in standardisation education (SE). Seminal steps are being taken in Asia towards a regional approach in standardisation education. Korea is leading the APEC-SCSC initiative to establish a regional Asian approach to SE (APEC SCSC, 2008). It is quite conceivable and not at all far-fetched that – given the absence of a coherent approach to standardisation education in Europe and America – well-trained standards experts from Asia may in the long run outperform their European and American counterparts and gain supremacy in international standardisation.

Standardisation is no longer merely an instrument for rationalisation but is used today by companies and states as a strategic instrument in competing for markets. For the European Commission, standardisation is essential to enhance and accelerate the sustainable growth of the European economy.
Education in the field of standardisation is therefore a part of the engine for sustainable economic development in Europe. However, European standardisation education activities are fragmented without a coherent approach. The only exception is at the level of standards bodies in the form of the CEN/CENELEC/ETSI Joint Working Group on Education about Standardization. The European Union – despite its comprehensive standards policy – lacks a corresponding European strategy in standardisation education. To strengthen Europe's position in the international arena, a comprehensive European approach to standardisation education is needed. The purpose of this would be to increase awareness not only of standards and standardisation, but also of standards education itself, and to prepare people for activities

related to standards and standardisation. This should be done by moving in the direction of a system of standardisation education in Europe including mutual recognition of educational qualifications, study achievements and the contents of curricula. This would create an EU market for standardisation experts according to a predefined qualifications framework.

- The prime objective of a European qualifications framework for education in the field of standardisation (EQF-S) is a flexible linking of knowledge (theoretical and factual knowledge), skills (cognitive and practical skills) and competency (responsibility and independence). The EQF-S should also address the interfaces to various subject disciplines, regardless of the level in the educational system on which this takes place.
- The EQF-S has to be linked with a national qualifications framework for education in the field of standardisation (NQF-S) in the EU member states.
- In addition, a global qualifications framework in the field of standardisation (GQF-S) may be developed to prepare students as well as employees in companies to connect to the changed conditions in a global employment system (industry and commerce, state institutions, etc.). Nevertheless, an EQF-S is needed to address specific European values, approaches, business practices and standardisation practices, and to stimulate standardisation education in Europe.

A European programme needs elements including:

- a standardisation job profile research project (who needs to know what?)
- development of curricula for Bachelors and Masters level based on European culture as well as market needs (for e.g. technical, business, economics and law studies)
- developing teaching materials, in particular materials that are attractive for both students and teachers such as teaching cases
- a repository of teaching materials and approaches
- investigation of the need for European diplomas for standardisation with education programmes to prepare for these diplomas
- developing both these programmes and the examination infrastructure
- establishment of an infrastructure of academics in the field of standardisation education including (endowed) chairs on standardisation throughout Europe
- building an infrastructure for close cooperation between academics and practitioners
- developing a sustainable funding structure for standardisation education
- establishment of an office at European level (European Office for Standardisation Education) for the lasting support of a European education system in the field of academic standardisation, funded by the EU Commission.
- establishment of a standardisation education steering group at the European level in which industry, government, standards bodies and academia plus other educational institutions participate, plus parallel steering groups in the EU and EFTA member countries.

III    BACKGROUND

# 1.    Introduction

Recently, the standards community has increasingly been focusing on standardisation education (Hesser & Czaya 1999, de Vries & Egyedi, 2007; de Vries, 2011). There are several reasons for this. Firstly, it is difficult to overrate the impact that standards and standardisation have on modern societies and social interaction. Standards, among other things, are powerful instruments: they reduce transaction costs and information asymmetries, constitute structural/systemic interrelations – e.g. in the way they shape and/or constitute markets – and serve the public interest. Without standardisation the industrial revolution, the computer revolution and the transition from an industrial society to one based on information and knowledge would have been impossible. Standardisation, however, can fully unfold its beneficial potential only as long as the relevant actors (regulatory authorities, standards developing organisations, companies, consumers, users and other interest groups) are able to make appropriate decisions and to conduct their standards activities in a professional, effective fashion. Together with metrology, testing and quality management, standardisation and the organisations to support it are essential elements of a country's 'MSTQ system' and are essential for facilitating international trade (WTO, 2005),

Secondly, the demand/need for standards expertise can be expected to grow in the future for a number of reasons: socio-economic and technological integration will continue in the long term and crucially depend on the availability of adequate standards and the capability to develop such standards. Furthermore, adequate standards are a prerequisite for advanced technologies such as nanotechnology to enter markets on a large scale. However, the preparation of such advanced standards is becoming increasingly demanding and complex, which immediately calls for sufficient manpower and expertise to accomplish the necessary tasks. Political actors like the European Union increasingly refer to standardisation as a regulatory instrument which can only be coherently maintained with sufficient standardisation expertise in the political realm and as a means of enhancing innovation. Furthermore, where economic cooperation/integration – e.g. in the form of mutual trade agreements or regional trade agreements – is negotiated, standardisation issues necessarily play an important role and need to be addressed adequately.

As a result of these trends, job requirements have risen sharply for everyone who deals with standardisation issues – from the technical expert who prepares standards in a Working Group to the policy-maker who relies on standardisation as a regulatory instrument. In this respect the "good old way" of standardisation education – i.e. learning by doing/learning on the job without any prior or, at best, only limited knowledge of standardisation – is no longer really viable and new educational concepts are needed. We elaborate on the needs for standardisation education in Chapter 2. Asian countries have recognised the new situation and therefore we continue with a description of developments in Asia in Chapter 3. In Chapter 4 we describe and analyse the situation in Europe and in Chapter 5 we conclude that Europe's competitive advantage is declining. Then in Chapter 6 we analyse why it is difficult to implement standardisation education. This implementation should be at the national level or, in countries like Germany, the level of states or provinces within the country. The necessary measures at country level are described in Chapter 7. Necessary developments at the national level may be stimulated at the European level. Finally, Chapter 8 describes possible European initiatives.

## 2    Need for standardisation education

The need for education about standardisation has been addressed in several studies (Verman, 1973; Hesser & Czaya 1999; Korukawa 2005; de Vries, 2005; de Vries and Egyedi, 2007; Krechmer, 2007; Cooklev, 2010). This chapter subsequently addresses the needs in industry and the needs of standards bodies and governments.

### 2.1    Industry

The need for standardisation education in industry is latent rather than manifest. Take the example of industry participants in international standardisation. Research has revealed more than 100 factors that contribute to successful participation in international standardisation committees (Brons, 2007). Most participants in international standardisation are not aware of these factors. They spend several days or weeks a year in standardisation activities and have the impression that they are doing a good job but are not aware that their efforts could be much more effective.

There is some demand for "standards engineers" (experts) but there are neither official descriptions nor formal training for such positions. Due to the lack of a formal curriculum, the selection of such professionals is mostly based on his/her previous practical experience in standards and related standardisation activities, and on his/her proficiency in specific soft skills. From an exploratory search of the empirical data collected from a survey on companies seeking "standards engineers" (unpublished research findings by Carla Freericks, summarized by Hesser (2010)) it was possible to identify that job offers for standards engineers (SE) demanded responsibilities such as: a) being aware of/interpreting standards, b) standards development, c) standards implementation, d) standards compliance/certification/ inspection/evaluation, e) standards diffusion/training. These responsibilities demand skills such as "diplomatic abilities", "language skills", "problem/conflict solving abilities", "sensitivity/awareness for other cultures, needs and backgrounds", "decision-making capability", "evaluation skills/analytical abilities", "ability to build a consensus", "technical leadership", etc.

In addition to the technical standardisation experts (standards engineers), who are usually appointed as technical experts for the development of standards in standardisation committees, there are two other demand groups in companies. Firstly, the employees in the standardisation departments – if any – are main contacts and coordinators for all standardisation activities within the company; secondly, the management as a decision/maker for strategic standardisation activities in the company has to be granted a principal role. Here, especially, the strategic aspects of standardisation are important.

Most companies, in particular SMEs, have no standards expert or standardisation department at all. Research by de Vries et al. (2009) shows that many SMEs fail to profit from standards and standardisation and that they face a sequence of barriers. The first barrier is lack of awareness and this is in particular the barrier for which education is the solution. Once this barrier has been taken, other barriers apply, for instance: finding the right standard, interpreting the text, implementing the standards and for solving those problems again education is part of the solution. So companies, whether small, medium-sized or large, need qualified academics, both at management and at technical level, who have at least enough education to be able to see the potential of standards and standardisation and then, for specific tasks, may seek further professional training.

It is particularly in the group of managers where insufficient qualification can be detected. In this area there is often not only a lack of general awareness of standardisation but also a

lack of expertise in recognising standardisation as a specific instrument for management actions and for the benefit to their companies beyond the confines of the company. Due to their limited specialist expertise in the field of standardisation, the management is therefore not able to comprehensively represent the company's interests in complex global competition.

Education in the field of standardisation at universities in engineering sciences, management science, economic science and law is therefore a key strategy. Training and qualifying management provides the foundation for the competitiveness of the European Economic Area in the global market.

## 2.2    Standardisation bodies

Standards and standardisation are core business for standardisation bodies, so one might expect them to be centres of standardisation expertise. In South Korea it was the trade union of employees of the Korean Standards Association who saw the need to professionalise KSA staff and this is the reason why they initiated a workshop that formed the start of academic standardisation education activities (KSA, 2003). DIN requires from its staff that they should have passed exams in some standardisation courses (Behrens, 2010). However, such recognition of the importance of real standardisation expertise for standardisation bodies is not widespread. Part of the professionalisation of international standardisation could thus be to better educate technical officers of standardisation bodies. The system of international standardisation could be upgraded by moving in the direction of granting ISO and IEC secretariats only to technical officers with a recognised diploma in standardisation.
Standards bodies are not only potential users of standardisation education, but many of them offer it as well, albeit only for further education. Generally the focus is on elucidating the contents of specific technical standards or, for instance, standards for management systems such as ISO 9001 (quality management) and ISO 14001 (environmental management). Some standards bodies are commercial players on the further education market. They offer courses for which companies and other stakeholders are willing to pay but this insufficiently solves the problem related to the first barrier for SMEs to profit from standards and standardisation: their lack of awareness. Standards bodies' further educational activities can be seen as complementary to those of universities and other public educational organisations. It is therefore important to distinguish between

1   professional training in the field of standardisation and
2   academic education in the field of standardisation

In the professional training sector, the national standards bodies provide good measures for company employees to achieve professional qualifications.

Academic education in the field of standardisation is not an activity of standardisation bodies, it should be integrated into the state education system at universities, in line with the European tradition. This report is therefore also and especially directed towards the decision-makers in the national governments and the European Commission.

## 2.3    National governments

National governments play different roles related to standards and standardisation (De Vries, 1999, Section 2.2.5), they can:

1   support standardisation as a part of their general role in stimulating business performance and international trade;

2   create a legal foundation for standardisation;

3   carry out standardisation activities themselves (in many countries, in particular in the former Soviet Union and in developing countries, the national standardisation organisation is a governmental agency);

4   supplement, simplify, or improve their legal system with standardisation by making references to standards in laws;

5   use standardisation for specific public sector tasks (for instance, in the areas of public health, environmental protection, traffic infrastructure, army, and police. Then governmental interests are comparable to those of companies with a dominant market position or companies as main users);

6   use standardisation to improve their performance in areas that are not specifically governmental (for instance, procurement, IT systems, occupational health and safety of government workers).

In all roles they would profit from better standardisation education, and government officers in charge of roles 2, 3 and 4 need very specific standardisation competence. For role 1, standardisation education is one of the policy instruments that the government might use. Moreover, government has a seventh role:

7   it is responsible for education. The government may include standardisation knowledge in its criteria for accreditation of educational programmes (Spivak and Kelly, 2003; Cooklev, 2010).

Many governments are insufficiently aware of these different roles and lack a policy that addresses the different roles. An exception is the policy of the German government, which focuses on the first role but also mentions all other roles with the exception of 3 (not applicable) and that in education (Die Bundesregierung, 2009).


## 3      Developments in Asia

Asian countries such as Korea, Japan, China, Thailand and Indonesia are presently at the forefront of standardisation education. Most of the Asian countries have a national standardisation education strategy. Governments, universities and standardisation organisations work hand in hand. At the 18th APEC Ministerial Meeting in Hanoi, Vietnam, 15-16 November 2006, the ministers of the Asia Pacific Economic Cooperation recognised the importance of standards education and encouraged their members to develop reference curricula and materials to address the significance of standards and conformity assessment to trade facilitation in the region (APEC, 2006). Following this decision, a project was set up in which the Korean Standards Association (KSA) has the lead (Choi (Ed.), 2008). It includes the development of curricula and teaching materials and training of teachers. Achievements to date are as follows: teaching materials include a textbook, conferences have been organised, an overview of existing courses is available, a repository of materials includes more than 1000 entries, see http://www.wisestandard.org/. Participating countries include almost all APEC members: most countries in East Asia but also Russia, Australia, New Zealand, Peru and the United States.

At the national level, South Korea is far ahead in implementing standardisation education in academic curricula. It does more than Europe as a whole (Choi (Ed.) 2008, Czaya et al. 2010). The USA is lagging even further behind. Korea has devised an all-encompassing top-down approach to standardisation education, which is laid down in its "Five-year National Standards Master Plans" (of 2001 and 2006). These master plans aim to create an advanced standardisation system and build up adequate standards expertise and manpower (Lee, 2007).

The Korean Standards Association (KSA) contributes to this plan, as it provides expertise and coordinates the University Education Programme on Standardisation (UEPS), under which multidisciplinary one-semester courses on standardisation have been introduced in Korean universities on a broad scale. The courses started from scratch in 2004 and have provided this education for a maximum of up to 7,000 students per year, with the maximum being reach in 2007. Recently the number decreased to 3957 in 2010 because less money was available (data received from Donggeun Choi, Korean Standards Association). UEPS-related content is provided in Korea in the form of a textbook to which various Korean standards experts have contributed and which is distributed free of charge to students. UEPS is not confined to engineering sciences but also targets social sciences. Standardisation education is taking place everywhere within Korea's educational system. Even in elementary schools standards-related content is already conveyed to pupils in a play-based approach via standards competitions.

Japan also takes a well-devised approach to standardisation education and the development of human resources in standardisation. The Ministry of Economy, Trade and Industry (METI) and the Japan Industrial Standards Committee (JISC) have set up an "Action Plan for Enhancing International Standardisation Activities of Japan", an investment of USD 1,000,000 in the period between 2005 and 2010 (Tanaka, 2011). In this plan three categories of standards experts (standards writers, developers and researchers related to standardisation) are identified and addressed accordingly. For instance, standards writers and developers are offered training courses to enhance their skills in writing and negotiating international standards. At the same time, teaching materials and lectures are prepared for universities and graduate schools, and research into standardisation issues is supported by JISC and METI. In 2007, 15 professors in 13 Universities gave lectures in the field of standardisation in Japan. Emphasis is increasingly being placed on strategic aspects of standardisation (business strategies, strategic management, intellectual property rights) and to a lesser extent on technical details (Furukawa, 2007). Similar to the Korean example, standardisation issues are also being addressed in schools. Higher education should give students comprehensive knowledge of economic benefits of standards, development processes, business applications, international trade, etc. and provide insights into business transactions, governmental policies, and working in the present global world, etc. (Tanaka, 2011). The Japanese programme had expanded the number of academic institutes having SE. Educational materials have been developed including books. Pedagogical methods have been improved (Tanaka, 2011).

In China, the China Jiliang University is leading the way in standardisation education (Song, 2007, 4; Song, 2008). Its programme on standardisation offers students a curriculum with a focus on international standardisation and quality management and the opportunity to gain hands-on experience in standardisation, e.g. in the form of industry internships. In 2007, China Jiliang University – represented by Prof. Song Mingshun, director of the programme on standardisation – received the (inaugural) ISO Award for Higher Education for its undergraduate programme on standardisation.[1] The Chinese National Institute for Standards CNIS is the only national standards body in the world paying serious attention to research and development for its own business of standardisation, including standardisation theory (Bai, 2011).

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[1] The authors have successfully cooperated with China Jiliang University/Prof. Song in the EU-Asia Link project (Prof. Dr. W. Hesser) 'Standardisation in Companies and Markets. Jiliang University uses the e-learning platform 'ILIAS' to convey content in standardisation online See Hesser/Siedersleben (2007), http://www.pro-norm.de/ and http://www.asia-link-standardisation.de/ for details on the EU-Asia Link project.

At the same time reference should also be made to less powerful countries, with Indonesia serving as an example here. Since 2005, Badan Standardisasi Nasional (BSN) has been developing standardisation education by involving 18 universities throughout Indonesia. It began with Diponegoro University. In addition, BSN in 2010 established cooperation with four universities in Indonesia, namely Riau University, University of Sam Ratulangi, Tanjungpura University and the University of Palangkaraya, by signing an MoU between the chairman of BSN and representatives from each university. This first event for education (The Standardisation Education Forum: The University as a Major Pillar of Standards Development, Jakarta, November 3rd, 2010) on standardisation was highly praised by the participants coming from 22 universities, all involved in cooperation with BSN. They proposed that the same event should be held at their universities so that more Indonesian professors could obtain knowledge of education in standardisation as a new discipline in Indonesia.

Malaysia is holding a take-off conference for a national approach to standardisation education December 2011. Other Asian countries active in this field include the Philippines, Sri Lanka, Taiwan, Thailand and Vietnam.

# 4    Situation in Europe

## 4.1    Academia

### 4.1.1   European level

To assess the current state of SE activities in Europe the authors drew upon their own surveys and various other sources (Acyl/Borde, 2003; Kurokawa, 2005; de Vries, 2005; de Vries/Egyedi, 2007; Choi, 2008; Choi, /de Vries/Kim, 2008; Hesser/Czaya, 2008). More than 80 European academic entities active in SE were identified, although this number should instead be regarded as a "lower boundary", because presumably not each and every European SE activity was disclosed. Most European SE activities are taking place in higher education establishments. Approximately 70% of the above-mentioned entities represent universities, business schools, technological educational institutes and the like. Often standardisation issues are addressed in passing in a broader context and/or for rather practical reasons and courses entirely devoted to standardisation are still an exception. Undergraduate study programmes in particular, with their strict curricula and timetables, do not leave much room for "exotic topics" like standardisation.

Currently standardisation education at the academic level is inadequately based on the outcome of scientific research. At the same time, a study by Choi and Lee (2011) – albeit focusing exclusively on publications in English – shows that European researchers provided more than one third of the total amount of academic papers on interrelations between standardisation and innovation, indicating that Europe plays a substantial role in the global standardisation research community. The connecting organisation for the European standardisation research community is the European Academy for Standardisation EURAS (http://www.euras.org). EURAS members have been trying to stimulate standardisation education and have actively tried to promote the inclusion of education in standardisation policies at the national and at the European level for more than a decade (e.g. Hesser 1999, Hesser 2000). This report is an example of a contribution by EURAS itself. Initiatives to stimulate standardisation education have been coming from EURAS members for more than 10 years and include:

- International Workshop on Telelearning: Standardisation for academic and business communities within the EU. Universität der Bundeswehr, Hamburg 28 June 2000. (Participants AENOR, AFNOR, DIN, DKE, PKN, SIS, UNI, CEN, ETSI, Siemens, Thyssen Krupp, HAUNI, etc.)
- EU Asia-Link project 2004-2007: Curriculum and book entitled Standardisation in Companies and Markets (Hesser, Feilzer & de Vries, 2007; 3rd Edition 2010)
- E-learning platform: Standardisation in Companies and Markets developed by Prof. Hesser, Helmut Schmidt University, www.pro-norm.de
- ICES Workshop 2007 (Egyedi and de Vries, 2007)
- Standardization education track in the 7th International Conference "Standardization, Protypes and Quality: A means of Balkan Countries' Collaboration, 2010, Zlatibor, Serbia (Mijatovic (Ed.), 2010)

In practice, research activities and educational activities are rather weakly correlated: many scholars active in standardisation research do not necessarily engage in SE. Some university teachers with practical experience in standardisation, mostly in technical fields, pay some attention to certain standards rather than to the process of developing these standards and usually without being aware of academic findings about standardisation as such.

### 4.1.2   National level

A limited number of universities pay attention to standardisation in a more structured way. Universities with standardisation programmes include the Belarusian National Technical University (Serenkov, 2010), the French Ecole Internationale des Sciences du Traitement de l'Information (Beauvais-Schwartz and Bousquet, 2010) and the French University of Technology of Compiègne (Caliste and Farges, 2007), the Clausthal University of Technology (Germany, Prof. Müller), and the Technical University of Berlin (Germany, Prof. Blind).

The Netherlands has a unique situation: the Netherlands Standardisation Institute NEN created an endowed chair of standardisation, in 1994, at the Rotterdam School of Management, Erasmus University. "Endowed" means that NEN pays the professor, currently Prof. Dr Knut Blind, for his appointment on a one-day-a-week basis. NEN provides additional money so that he can receive support. The chair not only performs standardisation education at its own university but also

- supports standardisation research and education at other universities (by organising, maintaining and supporting an informal network of academic researchers in standardisation encompassing 9 of the 12 Dutch universities);
- gives "status" to the topic of standardisation by the simple fact of having a chair for it;
- further develops standardisation as a scientific discipline;
- participates in policy debates on topics such as how to improve national environmental policy by making use of standards; in some cases, the voice of a professor is more convincing than the voice of the general director of a standards body.

Additionally, students help NEN with feasibility studies for new standardisation topics, which has resulted in new activities for NEN. Five students educated in Rotterdam have become employees of NEN. Advice by the chair has contributed to better stakeholder involvement in NEN: the number of participants has increased by 30%, which has also contributed to NEN's healthy financial figures (NEN, 2010). Apparently, NEN gets a return on its investment in the Chair.

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Another standardisation chair, at the Helmut Schmidt University in Hamburg (Prof. Hesser, see Hesser and Czaya, 1999), was founded in 1984 and had the task of teaching the subject of standardisation as an optional subject in the undergraduate course leading to Diplom/Master for students of Mechanical Engineering and Industrial Engineering. An interdisciplinary teaching concept on standardisation was developed and taught here for the first time (www.pro-norm.de) and the first extensive textbook on standardisation in English was produced (Hesser et al., 2010). Regardless of the faculty's recognition of these achievements, restructuring measures in the German Federal Armed Forces have led to the chair being redesignated/renamed to cover the specialisation "Computer-assisted methods in defence technology" following the retirement of Prof. Hesser, Autumn 2010.

Scholars who offer full-scale curricula on standardisation in higher education – from which, by the way, a European SE approach can readily draw – often take a multidisciplinary or interdisciplinary approach and frequently apply advanced didactical instruments. For instance, Jan Smits of the University of Technology Eindhoven asks his students to write a weblog on standardisation, Wilfried Hesser of Helmut Schmidt University provides a full-scale online-curriculum[2], and Tineke Egyedi of Delft University of Technology offers the simulation exercise 'Setting Standards' to students, policy makers and standardisers[3]. However, courses or curricula entirely devoted to standardisation are still an exception. In primary education in Europe, there are no SE activities, and in secondary education no coordinated or systematic SE activities except in Turkey.

### 4.2    Standardisation organisations (SDOs)

#### 4.2.1   European SDOs

The European standards bodies CEN, CENELEC and ETSI have a number of activities for further education:
- CEN StandardsDays are held twice a year, in the form of two-day information sessions. The aim here is to raise awareness and to provide specialised training. Target groups: all actors interested in the European standardisation system.
- CEN's Technical Assistance Programmes offer training sessions and a collection of training material (CD-ROMs, brochures, booklets).
- CENELEC provides awareness courses for newcomers, tailor-made training for professionals upon request, and promotional material.
- ETSI regularly organises seminars for newcomers and members to facilitate active participation
- CEN, CENELEC, and ETSI established a Joint Working Group on Education about Standardization (JWG-EaS), March 2010.

CEN, CENELEC and ETSI have at present no all-encompassing SE strategy but the JWG-EaS has prepared a strategy document (CEN/CENELEC/ETSI JWG EaS, 2011).

#### 4.2.2   National SDOs

Standards bodies in large European countries like the United Kingdom, France and Germany explicitly address SE in strategy papers or position papers (BSI, 2003; DIN, 2004; AFNOR; 2006), whereas many smaller European countries tend to have no SE strategy at all. In small

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[2] See www.pro-norm.de or http://www.asia-link-standardisation.de/ for details.
[3] See http://www.standards-education.org/workshops/ices-2009/simulation-game for further information.

countries SE activities hardly go beyond vocational education provided by national standards bodies. It should be noted, however, that written declarations of intent need not necessarily translate into immediate action, and small countries like the Netherlands may lack an explicit SE strategy but nevertheless play a significant role in standardisation research and SE. European standards bodies are considering such measures that would significantly go beyond the above-mentioned engagement in vocational education.

Notably, the British Standards Institution's SE strategy (see the National Standardisation Strategic Framework (BSI 2003) is the most advanced in Europe[4]. BSI approaches all ages and educational levels, e.g. it offers interactive games on a range of topics for 7-19 year olds and provides teachers and students with tailor-made content including background information, lesson plans, case studies and testing sheets. Resources for engineering, manufacturing, applied science and design and technology courses are also available. BSI encourages schools to apply British Standards, e.g. BS 8901:2007 on sustainable event management and is trying to raise ecological awareness at schools with its GetGreenGo initiative[5].

However, the concept of the German Federal Government on standardisation policy also names assistance for education and training as an objective for supporting the implementation and distribution of results from innovation and research. Explicit emphasis here is placed on the needs-based consideration of standardisation in the academic curricula for natural sciences, engineering and economics. In order to implement these aims, the standards body DIN is being commissioned to submit offers to the various educational establishments for the design of tuition and to provide their own personnel to carry out these teaching sessions (The Federal German Government, 2009) – one may wonder why this is not fully left to the universities themselves, and whether standards bodies are equipped to prepare academic teaching (see also Czaya, Hesser 2008).

As described previously, it is important to point out that the national standards bodies are pursuing their own interests in the field of education for standardisation. The reasons for this may lie in the attractive educational markets in Europe. It is therefore important to distinguish between

1      professional further training in the field of standardisation and
2      academic education in the field of standardisation

In the professional training sector, the national standards bodies provide good measures for company employees to achieve professional qualifications. Academic education in the field of standardisation needs to be detached from commercial interests and to be suitably integrated into the state education system.

## 4.3      Governmental institutions

### 4.3.1   European Union

For the European Commission, standardisation is essential to enhance and accelerate the sustainable growth of the European economy (European Commission, 2011a). It sees standards and standardisation as very effective policy tools for the EU to ensure, inter alia, the functioning of the single market of products, the interoperability of networks and systems, consumer and environmental protection, and more innovation and social inclusion (European

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[4]See www.bsieducation.org for details.
[5] See www.getgreengo.com for details.

Commission, 2011a / 2011b). The benefits of standards for European industry are tremendous because they can support innovation and help to bridge the gap between research and marketable products or services (European Commission, 2011a). Standards can be used to address key societal challenges such as consumer protection, improving accessibility for disabled and elderly people, and environmental policies on issues such as climate change, green growth and the transition to a low-carbon and resource-efficient economy (European Commission, 2011a).

The European Union has closely co-operated with the European Standards Bodies CEN, CENELEC and ETSI to establish a highly advanced and largely successful regional standardisation regime and continues to rely on standardisation as a capable regulatory instrument in various policy fields[6]. The European Commission intends to continue this cooperation and support (European Commission 2011a / 2011b).

EU organs are increasingly acknowledging the significance of SE. The European Council "encourages the Member States to improve the position of standardisation in educational programmes and academic curricula, in order to familiarise students with the strategic benefits and challenges of standardisation, drawing on the expertise of standardisation bodies" (Standardisation and Innovation, Brussels, 25 September 2008 Council Conclusion 27).[7]

Standardisation education is also mentioned in the report of the Expert Panel for the Review of the European Standardization System - Standardization for a competitive and innovative Europe: a vision for 2020.[8] And also, the European Parliament asks for inclusion of standardisation in academic curricula.[9] In its most recent policy paper, the European Commission (2011a) formulates as Action 5: 'ESOs (European Standardisation Organisations), Member States and other standardisation bodies are expected to improve awareness and education about standardisation and potential links with research projects. Public knowledge about standardisation should be increased by means of training, awareness-raising activities and targeted workshops'.

The EU has furthermore established – but not maintained - an academic network in the field of standardisation in which standardisation education (SE) issues are addressed.[10] The Commission is striving to increase standards awareness within its own system and is introducing officers of research & development projects to standardisation. The aim is to promote the use of standardisation to disseminate R&D results and to facilitate the transfer thereof in markets, products and production processes. Additionally, the DG Enterprise ICT Steering Committee on standardisation policy has set up a working group on standardisation education which is, for example, preparing recommendations for specific actions and initiatives in standardisation education, albeit with a focus on ICT. Notably, the DG Enterprise initiated a meeting on standards and education in February 2009. At this "brainstorming meeting" EU representatives, national standards bodies (SB) representatives

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[6] See e.g. the Commission Communication 'Towards an increased contribution from standardisation to innovation in Europe' of 11 March 2008 (COM(2008) 133), the Commission's Action Plan for European Standardisation of June 2008 and the Commission's website on standardisation policy (http://ec.europa.eu/ enterprise/standards_policy/index_en.htm) for the latest proposals, initiatives and developments in European standardisation.

[7] See http://ec.europa.eu/enterprise/policies/european-standards/files/standards_policy/standardisation_innovation/doc/councilconclusions_20080925_en.pdf
In the draft version of the EU policy document on standardisation and innovation, education was also mentioned. In the final version it has been deleted. (See: http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=COM:2008:0133:FIN:en:PDF)

[8] See http://ec.europa.eu/enterprise/policies/european-standards/files/express/exp_384_express_report_final_distrib_en.pdf

[9] See http://www.europarl.europa.eu/oeil/FindByProcnum.do?lang=en&procnum=INI/2010/2051

[10] See http://ec.europa.eu/enterprise/standards_policy/academic_network/index.htm.

and standardisation experts discussed the possible scope for a coherent EU approach to SE. However, no far-reaching decisions were made on this occasion: participants agreed that it is necessary to set up a repository of educational material. EU representatives asked for stronger European presence in ICES.[11]

Of course, standardisation and thus standardisation education is also important for the members of the European Free Trade Association EFTA. In many cases they follow the EU. The active involvement of EFTA in the CEN/CENELEC/ETSI Joint Working Group on Education about Standardization signals their interest in standardisation education.

To summarise, it may be pointed out that the European Union has established a European standardisation system in decades of close cooperation with European and national standards bodies. The EU Commission explicitly recognises responsibility for this system (European Commission, 2011a/2011b. Viewed from the ambitions of the EC in the field of standardisation, the current lack of standardisation awareness and knowledge should be seen as a serious obstacle for the EC to achieve its goals. To a certain extent it recognises the need for education but then the European Commission (2011a) points in the direction of members states and standards bodies to make this happen. Without denying this, we think the EC itself should also feel responsible for a European education system in the field of standardisation.

In this sense we also should mention the EC's intention to stimulate measures for SMEs (European Commission, 2011). The study by De Vries et al. (2009) shows that the intended measures such as reduced prices for standards are not the right ones – the major reason for lack of SME access to standard and standardisation is lack of awareness and the major solution to this problem is education – both at academic and lower levels. Once this problem is solved, a balanced set of other measures – many more than those mentioned by the European Commission – is needed to support SMEs. To support the EU's policies, including a better link between standardisation and research (European Commission, 2011), academic education is essential. Therefore, we have to conclude that there is a big discrepancy between policy and practice. It is the official policy of the EC and European Parliament to promote the European standardisation system, of which it has high expectations. However, current practice shows no more than fragmented standardisation education activities in the EU and hardly any programmes at the academic level.

### 4.3.2   National governments

In contrast to Asia, national governments in Europe show hardly any interest in standardisation education. Germany is an exception: the German Government has included standardisation education in its national standardisation policy (The Federal German Government, 2009). In the Netherlands, the government has funded a project to stimulate standardisation education as part of a programme to enhance awareness of standards and standardisation (Van Klaveren/Oostdijk, 2004). However, the project has not been continued and the impression is that impact is limited.

To sum up the state of SE in Europe: Europe is moving but there is still a long way to go and some obstacles (such as image, competent teachers...) have to be overcome. Without doubt, the decisions made and actions taken by the EU are crucial in this respect and might tip the balance in favour of standardisation – not only as a subject-matter in education but also as an acknowledged scientific discipline in its own right. Therefore, much depends not only on

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[11] Since there are many other notable approaches to standards education (see de Vries/ Egyedi, 2007, and the ICES Workshop presentations http://ts.nist.gov/Standards/ICES-Workshop-Presentations.cfm, 04.04.2008) these approaches feature different strengths that, if combined properly, may form a new, comprehensive and highly effective international educational system in standardisation.

the political willingness of EU organs to support SE initiatives, but also on the standardisation community's creativity and persuasiveness together with the didactic and scientific concepts it has to offer to policy-makers, decision-makers and society as a whole.

# 5    Europe's declining competitive advantage

Asian countries are not only catching up in standardisation education but also in staffing Technical Committees in international standardisation. Currently, formal standardisation is still dominated by European countries – Figure 1 shows the numbers of Participating (P) and Observing members (O) of eleven Technical Committees of the International Electrotechnical Commission. Until recently, Japan was the only very active Asian country, but participation by other Asian countries is emerging now.
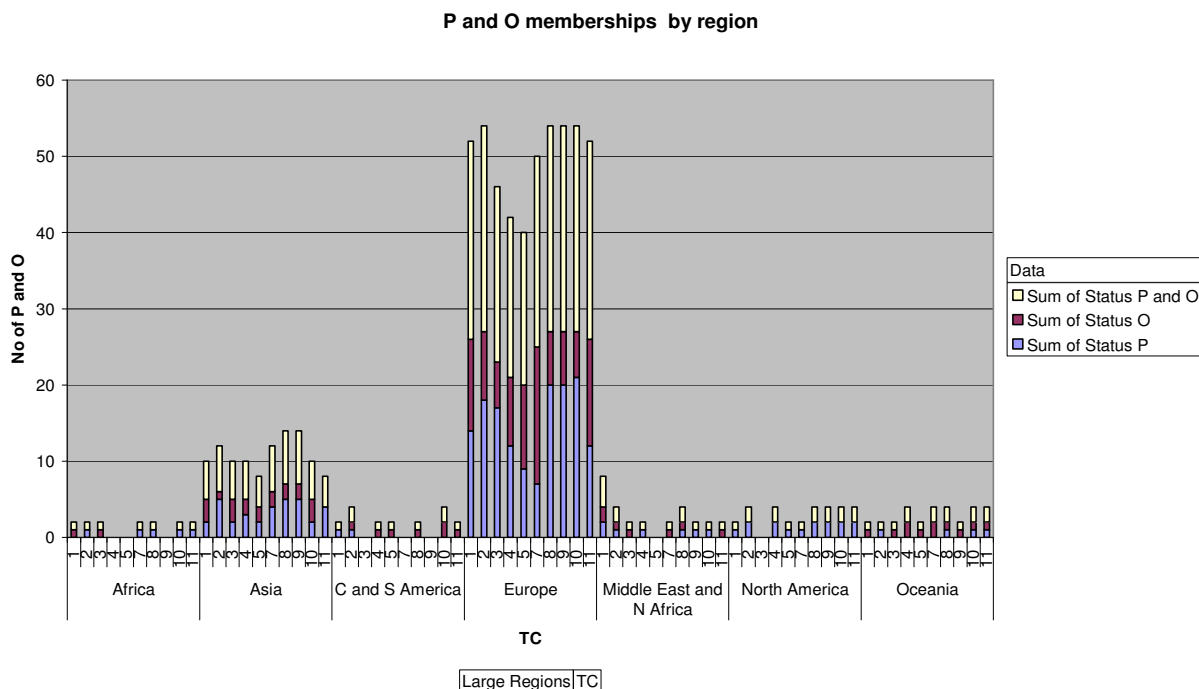


Figure 1. IEC regional membership

In terms of active involvement in the IEC, the top 10 of countries is Germany, United Kingdom, United States of America (the third powerhouse in international standardisation alongside the EU and the Asian region), Japan, France, Italy, Sweden, China, The Netherlands, and Australia.[12]

The above figures illustrate that Europe still plays a prominent role. Within Europe, there are huge differences. Countries in north-western and central Europe tend to be the most active. This may be related to the tradition of consensus-building that these countries have. Sometimes this is referred to as the 'Rhinelandic model' in contrast to the Anglo-Saxon

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[12] Source: Inventory in 2008 by Ana Amarie and Henk de Vries, Rotterdam School of Management, Erasmus University in cooperation with NEN. The amount of involvement has been measured by counting the numbers of secretariats, comments and experts per country for 40 IEC TCs, calculating an index for each of these, and giving equal weighting to each of these three.

model. In the Rhinelandic model, professionals in organisations have a lot of autonomy, and decisions within organisations are based on consensus. The main purpose of the organisation is to survive and in order to do that, the organisations establish and maintain contacts with a variety of external stakeholders. These values are reflected in the European quality management model EFQM. In the Anglo-Saxon approach, profit is the main business goal and top-management is decisive in achieving this. This is reflected in the Malcolm Baldridge National Quality Award, the criteria of which are laid down in American legislation. The Americans aim at short-term financial success while the Europeans have a longer time-perspective. Standardisation, by definition, needs a time-horizon of several years and this fits better to the European tradition. In Asia, the time horizon is much longer still, which makes the culture very suitable for systematic standardisation. The best-known Asian quality award is the (Japanese) Deming Prize. In this case, there is no explicit set of criteria, applicants are expected to understand their current situation, establish their own themes and objectives and improve and transform themselves company-wide. In this sense, the Asian culture has less affinity with standards although they do play a major role in Japanese quality approaches such as Kaizen. History shows that Asian countries are able to implement 'Western' concepts (like the quality management approach of the American expert Deming) in such a sophisticated way that they outperform countries in the West. This is what we can observe now in the field of standardisation: in standardisation education, Asia has the lead already and the launch in 2010, by South-Korea, of the standardisation research organisation Society for Standards and Standardisation in which 80 researchers are involved, suggests that the Asians will soon take over the lead in standardisation research as well.

Given the state of affairs, it is worthwhile envisaging a worst-case scenario for Europe, which may, however, become reality in the long run if standardisation education activities continue to be marginalised. In such a case, the expertise necessary to make qualified decisions in standardisation affairs in Europe (e.g. in policy-making, regulatory affairs, business, standards development, etc.) will diminish or even cease to exist in the long run. Moreover, recent complaints by the European Commission's administration about the quality of European standards developed by CEN suggest that the standardisation system in its current form already needs an upgrade. Such an upgrade depends on qualified people and thus on academic education. Without academic education that keeps pace with the Asians, not only will the quality of European standards, standardisation institutions and standardisation policies decline, but also the European influence in international standardisation and in other standardisation settings (i.e. de-facto standardisation). Non-European stakeholders, in particular from Asia, will gain increasing influence or even dominance in international standardisation and make the crucial decisions – sometimes against European interests – on the attributes of standards-driven innovations, systems, technologies, networks, etc. and the corresponding, highly profitable markets. As a consequence of the developments of standardisation education in Asia, Europe will not only turn from a leader into a follower in standardisation affairs but will also lose its competitive edge in many advanced technology fields and high-growth markets.

Indeed, such an envisaged power shift in international standardisation is to some degree the almost inevitable (but also natural) consequence of the rise of the Asian region (and China, in particular). In order to keep up with these aspiring countries/regions, Europe must maintain its competitive edge not only in innovation, but also in innovation-related standardisation *and* innovative approaches to standardisation, which will then result in more successful innovation.

# 6 Difficulties in getting standardisation education implemented

At the end of the day, industry and other stakeholders need employees' awareness of standards and standardisation, and industry, government, SDOs and other organisations need qualified people to do the different standards-related tasks. Academic and other education is needed to provide this qualification. But why should universities provide such education? Apparently, they see little urgency – the number of universities that have included standardisation in their curriculum is limited (Choi (Ed.), 2008; Czaya et al. 2010). In most cases where universities have implemented standardisation education, it is related to a stimulus from outside such as a national policy (Choi et al., 2009).

Implementing standardisation education is not easy and despite its recent growth, it is an exception rather than a rule that the topic of standardisation is included in education. A combination of barriers has to be overcome. A first barrier relates to the image of standardisation. Students may perceive standardisation to be 'dull' and therefore, if standardisation is the main topic of an elective course, choose something else which seems more appealing. A second barrier is related to teachers: they may be reluctant to pay attention to standardisation because they are not familiar with it, because they are not aware of its importance, because they are afraid that the topic is not attractive for students, and/or because the curriculum is overloaded with other topics already. If it were compulsory to address standardisation, the situation would be different.

A workshop on standardisation and academia ("Normung und Hochschule"), held in March 2009 at the Technical University Clausthal, elucidated some of the problems that scholars active in standardisation face at German (and presumably other European) universities. Basically, every scholar/professor has the academic freedom to teach and research standardisation issues. However, these scholars usually do not have the power to introduce standardisation as a subject on a broad scale or to make courses on standardisation mandatory – neither in their faculties nor their universities nor the university system at large. In decision-making bodies, such as faculty boards or university boards, where chairs, institutes and departments compete for scarce resources, standardisation (if perceived as a subject at all) ranks far behind other well-established topics, hardly even makes it onto the agenda and usually receives no support from other scholars. Neglected by university policy-makers and decision-makers, standardisation education thus remains at a stable minimum level of energy, in a marginalised position and is being carried out against all odds by a few lone "standards warriors".

Indeed, what holds for the university system a fortiori holds for society at large: with limited awareness and appreciation for standardisation in society, standardisation education ranks even lower in the public opinion. Key decision-makers see no necessity to engage in standardisation education and consequently, social investment in standardisation education remains marginal. Given the difficulties present in Europe to raise standardisation awareness and to mobilise support from key players in society, the standardisation community is looking for creative solutions to get the bandwagon rolling in standardisation education – an endeavour to which the reader is cordially invited to contribute. No powerful stakeholder is inclined to demand that courses in standardisation should be made compulsory for students. EU organs have capable legal instruments at their disposal to rule the Single Market and to further economic integration, but education policy is largely a matter for the member states (or even the federal states, as in Germany). Given that fact and given the far-reaching academic freedoms in higher education it is barely conceivable that the EU would forcefully interfere with national education policies in one way or another in order to "push through" standardisation as a topic of education. Secondly, any form of coercion would imply a

violation of the basic principles of standardisation, which include consensus-orientation, voluntariness and equality in standards preparation and use.

# 7    Implementing standardisation education at the national level

Developing and deploying a national standardisation education strategy and policy is a first prerequisite for a systematic national approach to standardisation education (Choi, de Vries and Kim, 2009; Denardis and Levin, 2009). The national strategy can be broad (addressing many areas of education) or limited and it can be detailed (specifying exactly what will be done when and by whom) or global. It seems that the more broad and detailed the strategy, the more standardisation education activities are in place in a country (Choi and de Vries, 2011). The hierarchical Asian Education System enables Asian countries to develop and implement a consistent nationwide standardisation education programme from primary school to university level. This is not feasible in Europe, the decentralised European education system and the variety of different standardisation organisations may result in a heterogeneous range of academic and post-formal education in standards, if any.

However, Dutch and Korean examples suggest that a combination of 'bottom-up' and 'top-down' is the best approach to take (de Vries, 2011). The process is bottom-up in the sense that individual teachers and their management have to become convinced that it is important to pay attention to the topic. This is not easy because the curricula are full already and the topic has to compete with other more established subjects. Then it is particularly convincing if industry and government demand the topic and, in order to achieve this demand, a standardisation education steering group is needed at the national level in which industry, government, standards bodies and academia plus other educational institutions participate. One side effect of deciding whether to participate in such a group is that it increases awareness of the importance of standardisation education for representatives of industry and the government. This group can also support another trajectory, 'top-down': to have standardisation included in the official terms that describe what students need to know when they leave school. This may not apply to universities, but for the lower levels it probably does. Such a target requires a lot of lobbying which will be easier if some education is in place already. Where applicable, reference to EU policies can be made or to national standardisation strategies (Council of the European Union, 2008, Conclusion 27). The Korean and Dutch examples show the following typical elements of a successful national approach:
- an inventory of needs for education
- a steering group in which the most important stakeholders are represented (industry, standards body, government, organisations in the field of education)
- a sound financial basis and commitment from all partners
- an action plan
- one or more devoted staff members, available for a period of years
- development of curricula and materials
- a train-the-teachers programme
- promotional activities
- performing education
- evaluation.

Activities can start with one or several teachers from one or a few schools and from there expand to a growing number of schools. Additionally, an approach for teaching practitioners is needed (Choi & De Vries, 2011; Giossi, 2010).

The better companies are organised on the topic of standardisation, the easier implementation of further standardisation education becomes. Preferably, both academic and professional communities will be formed – the professional community can become the national member of – the International Federation of Standards Users IFAN (http://www.ifan.org).

This enables:
- a networked relationship between academia and companies
- mutual exchange of information
- academia to be well informed about what firms and professionals expect from SE at universities.
- firms and professionals to be well informed on what academia has to offer in standardisation education.

Consequently, there should be close contact, but industry should not dominate the academic standardisation education activities nor should standards bodies. This is academia's own responsibility and they should also feel free to criticise current practices.


# 8 European level support for academic standardisation education

Although standardisation and education are national responsibilities, the common need in Europe to get more and better standardisation education calls for support at the European level. APEC provides a benchmark for such supra-national activities:
- designing curricula for different target groups – not with the intention to impose these but to serve as an example for teachers
- developing teaching materials, in particular materials that are attractive for both students and teachers such as teaching cases
- a repository of teaching materials and approaches
- teach-the-teacher programmes
- exchange of experiences

A European programme needs additional elements including:
- a standardisation job profile research project (who needs to know what?)
- development of curricula for Bachelor and Master levels based on European culture as well as market needs (for e.g. technical, business, economics and law studies)
- investigation of the need for European diplomas for standardisation with education programmes to prepare for these diplomas
- developing both these programmes and the examination infrastructure
- establishment of an infrastructure of academics in the field of standardisation education including (endowed) chairs of standardisation throughout Europe
- developing a sustainable funding structure for standardisation education

To make this possible, an organisational infrastructure at the European level is needed consisting of a European Standardisation Education Agency and a steering group. A small group of agency staff could carry out the necessary activities or coordinate activities that are outsourced to experts within and outside universities in the member states. To a certain extent such a European Standardisation Education Agency could be similar to other organisations at the European level created to pay attention to an issue that otherwise might be ignored:

Normapme (active to support the interests of Small and Medium-sized Enterprises (SMEs) in standardisation, see http://www.normapme.com) and ANEC (active to support the interests of consumers in standardisation, see http://www.anec.org). The agency should be funded by the EU Commission.

This agency needs a steering group at the European level in which member countries as well as a variety of European stakeholders (industry, government, standards bodies and academia) are represented. At the national level there should be parallel structures.

- Steering group responsibilities include:
  - promoting standardisation education,
  - coordinating standardisation education activities in the EU member states
  - developing a European Qualifications Framework for education in the field of standardisation (EQF-S). In analogy to the Bologna Process, the constituents of such a qualifications framework are:
    - conditions for taking advantage of the material taught
    - a standard period of study
    - feasibility of studying the material offered (time/expense required)
    - study objectives
    - course contents
    - forms of teaching and study
    - an examinations system

    (The responsibility of the development of specific curricula itself should be taken by the academic community).

    - stimulating the inclusion of standardisation among the official terms that describe what students need to know when they leave school.
      - This may not apply to universities, but for the lower levels it probably does. It requires a lot of lobbying which will be easier if some education is in place already.
      - Where applicable, reference can be made to EU policies or to national standardisation strategies (Council of the European Union, 2008, Conclusion 27).
  - giving guidance to the European Office for Standardisation Education
- Composition:
  - national representatives (at the national level a mirror committee should be establishedwith responsibility for the national coordination of activities in standardisation education and the national qualifications framework NQF-S, and comprising entities such as universities and other educational institutions, national standards bodies, industry, and national governments).
  - representatives of European organisations: trade associations, standards bodies (CEN/CENELEC/ETSI), education (EURAS representing academic education) as well as EU bodies.
- One side effect from the decision of whether to participate in such a group is that as such it increases awareness of the importance of standardisation education for industry and government representatives.

Stakeholders at the European level may also take other initiatives that trigger people to seek out standardisation education, for instance:

- by only granting secretariats of European standardisation to standardisation officers with proven abilities (diploma)

- by including standardisation in the requirements for EU-funded research projects (so researchers need standardisation knowledge for each project).

There are good reasons for the European Commission to invest in it: standardisation is an essential instrument for the single market without barriers to trade, for stimulating innovation, and for achieving societal goals such as sustainability. In order to achieve this, standardisation experts are needed with relevant academic education. Given these European stakes, it should not be difficult for the EC to support an academic infrastructure for education on standardisation.

Money is needed to cover costs of:
- the European Office for Standardisation Education
- steering group members and other participants (organisation, travel expenses, etc.)
- developing curricula in universities and other educational institutions
- implementation, such as part-time lecturers
- updating the teaching contents to ensure sustainability
- support of various implementation models (e.g. of endowed chairs, partner model)

Because standardisation is a 'horizontal' topic with medium-term to long-term impact it is difficult to find funding for it from industry and its associations, despite its enormous business impact. Because standardisation and hence standardisation education is in the best interest of the European project (e.g. in terms of enhanced trade and the development of new innovative markets, and sustainability and other societal needs) we therefore expect the European Commission to be a better source of funding. An additional reason for this is that better education should lead to more effective and efficient European standardisation, so that the EU receives better value for the money it invests in European standardisation.

## IV   REFERENCES

Adolphi, Hendrik (1997) *Strategische Konzepte zur Organisation der betrieblichen Standardisierung*. DIN Normungskunde Band 38. Berlin: Beuth Verlag.

Ailleret, Pierre (1985) *Dimensional Standardization*. Geneva: International Electrotechnical Committee.

APEC (2006) *The eighteenth APEC ministerial meeting joint statement*. Singapore: APEC.

Bai, Dianyi (2011) *Standardization Research and education in CNIS*. In: Lin Jianzhong et al. (eds) *Proceedings of ICES Workshop and WSC Academic Day 2011*. Hangzhou: China Jiliang University, pp. 30-42.

Beauvais-Schwartz, Nicole & Bousquet, Françoise (2010) *France – Fostering competitive intelligence*. http://www.iso.org/iso/iso-focus-plus_index/iso-focusplus_online-bonus-articles/the-2009-iso-award/2009-award_france.htm. (Visited 2011-05-29).

Behrens, Hermann (2010) *Education about Standardization – Competency of Standards Body Staff*. Presentation at the first meeting of the CEN/CENELEC/ETSI Joint Working Group on Education about Standardization, 2010-03-09, Brussels. JWG-EaS N008. Brussels: CEN-CENELEC Management Centre.

Bongers, Cornells (1980) *Standardization – Mathematical Methods in Assortment Determination*. Boston/The Hague/London: Martinus Nijhoff Publishing.

Bongers, Cornells (1982) *Optimal Size Selection in Standardization: A case Study*. In: The Journal of the Operational Research Society, 33(9), 793-799.

Brons, T.F. (2007) *Effective Participation in Formal Standardization: A Multinational Perspective*. Rotterdam: Rotterdam School of Management.

Caliste, Jean-Pierre & Gilbert Farges (2007) *A French University: Encouraging hands-on experience*. In: ISO Focus, 4(11), 13-14.

CEN/CENELEC/ETSI JWG EaS (2011) *Policy on Education about Stadnardization*. Brussels: CEN-CENELEC Management Centre. ftp://ftp.cen.eu/CEN/Services/Education/Education/Policy%20on%20Education%20about%20Standardization.pdf

Choi, Donggeun (Ed.) (2008) *APEC SCSC Education Guideline 1: Case Studies of How to Plan and Implement Standards Education Programs and Strategic Curriculum Model*. Seoul: Korean Standards Association.

Choi, Donggeun & Henk J. de Vries (2011) *Standardization as emerging content in technology education*. In: International Journal of Technology and Design Education. International Journal of Technology and Design Education, 21(1), 111-135.

Choi, Dong Geun, Heesang Lee (2011) *Research Profiling for 'Standardization and Innovation*. In: Scientometrics (forthcoming).

Choi, Donggeun; Henk J. de Vries & Danbee Kim (2009) *Standards Education Policy Development: Observations based on APEC Research*. In: International Journal of IT Standards and Standardization Research, 7(2), 23-42.

CNIS (2011) *Data of the CNIS Workshop on Knowledge System of Standardization*. Beijing: China National Institute of Standardization.

Cooklev, Todor (2010) *The Role of Standards in Engineering Education*. In: International Journal of IT Standards and Standardization Research, 8(1), 1-9.

Council of the European Union (2008) *Council Conclusions on standardisation and innovation*. 2891st Competitiveness Council meeting, 2008-09-25. Brussels: Council of the European Union.

Czaya, Axel; Tineke Egyedi & Wilfried Hesser (2010) *The current state of standardization education in Europe*. In: Ivana Mijatovic and Nedelsko Živković. (Eds) *Proceedings 7th*

*International Conference "Standardization Protypes and Quality: A means of Balkan countries collaboration"*, 85-90. June 8th – 9th 2010 Zlatibor, Serbia. Belgrade: University of Belgrade, Faculty of Organizational Sciences.

de Vries, Henk J.; Blind, Knut; Mangelsdorf, Axel; Verheul, Hugo & van der Zwan, Jappe (2009) *SME Access to European Standardization - Enabling small and medium-sized enterprises to achieve greater benefit from standards and from involvement in standardization.* Brussels: CEN and CENELEC. ftp://ftp.cen.eu/CEN/Services/SMEs/SME_Web/SME_Access_Report.pdf (Visited 2011-05-29).

de Vries, Henk J. & Egyedi, Tineke M. (2007) *Education about Standardization – Recent Findings.* In: International Journal for IT Standards and Standardization Research, 5(2), 1-16.

de Vries, Henk J. (1999) *Standardization – A Business Approach to the Role of National Standardization Organizations.* Boston/Dordrecht/London: Kluwer Academic Publishers.

de Vries, Henk J. (2002) *Standardization – Mapping a field of research.* In: Sherrie Bollin (Ed.), *The Standards Edge*, 99-121. Ann Arbor, MI: Bollin Communications.

de Vries, Henk J. (2003) *Kenbaarheid Normalisatie en Normen – Deelproject 9b HBO-onderwijs – Tussenrapportage.* Delft: NEN.

de Vries, Henk J. (2011)

de Vries, Henk J. & Egyedi, Tineke M. (2007) *Education about standardization – recent findings.* In: International Journal for IT Standards & Standardization Research, 5(2), 1-26.

Denardis, Laura & Arthur Levin (2009) *Bridging the standardization gap – ITU-T Research Project: Measuring and Reducing the Standards gap.* Geneva: International Telecommunication Union.

Die Bundesregierung (2009) *Normungspolitisches Konzept der Bundesregierung.* Berlin: Die Bundesregierung.

European Commission (2011a) *Communication from the Commission to the European Parliament, the Council and the European Economic and Social committee – A strategic vision for European standards: Moving forward to enhance and accelerate the sustainable growth of the European economy by 2020.* COM(2010) 311 final. Brussels: European Commission. http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=COM:2011:0311:FIN:EN:PDF.

European Commission (2011b) *Proposal for a regulation of the Euoropean Parliament and of the Council on European Standardisation and amending Council Directives 89/686/EEC and 93/15/EEC and Directives 94/9/EC, 94/25/EC, 97/23/EC, 98/34/EC, 2004/22/EC, 2007/23/EC, 2099/105/EC and 2009/23/EC of the European Parliament and of the Council.* COM(2010) 315 final. Brussels: European Commission.

Fukuda, Yasukazu (2008) *Initiatives for Increasing the Number of Standardization Experts in Japan – Education and Training in Standardization.* Lecture held on the ICES Workshop on Global Perspectives and Strategies for Education about Standardization. Gaithersburg, 2008-02-21. http://ts.nist.gov/Standards/upload/Initiatives_for_Increasing_the_Number_of_Standardization_Experts_in_Japan_Education_and_Training_in_Standardization.ppt (Visited 2011-05-29).

Furukawa, Yuji (2007) *A Japanese university: Educating standardization strategists in business.* In: ISO Focus, 4(11), 15-16.

Ganeva, Lilija; Branimir Sandalski & Radoslav Kotev (2010) *Contributions of the Bulgarian Union of Standardization for the European Integration of the Republic Bulgaria.* In: Ivana Mijatovic and Nedelsko Živković (Eds). *Proceedings 7th International Conference*

*"Standardization Protypes and Quality: A means of Balkan countries collaboration"*, 29-38. June 8th – 9th 2010 Zlatibor, Serbia. Belgrade: University of Belgrade, Faculty of Organizational Sciences.

Gerundino, Daniele (2010) *Standards in economic development and trade.* In: ISO Focus, 1(1), 35.

Gerundino, Daniele (2007) *ISO e-learning completed! A convenient and fun way to become a standardization expert.* In: ISO Focus. 4(11), 39-43.

Giossi, Stella & Adamantios, Papastamatis (2010) *The effective teaching of standards in a lifelong learning world.* In: Ivana Mijatovic and Nedelsko Živković (Eds). *Proceedings 7th International Conference "Standardization Protypes and Quality: A means of Balkan countries collaboration"*, 118-125. June 8th – 9th 2010 Zlatibor, Serbia. Belgrade: University of Belgrade, Faculty of Organizational Sciences.

Hesser, Wilfried & Czaya, Axel (1999) *Standardization as a subject of study in higher education.* In: ISO Bulletin, 30(6), 6-11.

Hesser, Wilfried (2008) *Overview of Education in Standardization at German Universities and Colleges.* Lecture held on the ICES Workshop on Global Perspectives and Strategies for Education about Standardization. Gaithersburg, 2008-02-22. http://ts.nist.gov/ Standards/upload/Overview_of_Education_in_Standardization_at_German_Universities_ and_Colleges.ppt (Visited 2011-05-29).

Hesser, Wilfried & Czaya, Axel (1999) *Standardization as a subject of study in higher education. A vision.* In: ISO Bulletin, 30(6), 6-12.

Hesser, Wilfried & Siedersleben, Wenke (2007) *Standardization goes east. The European-Asian academic network – international and multimedia-based.* In: ISO Focus, 4(11), 21-24.

Hesser, Wilfried; Feilzer, Albert & De Vries, Henk J. et. al. (2010) *Standardisation in Companies and Markets.* 3rd Edition, Hamburg : Department of Standardisation and Technical Drawing, Helmut-Schmidt-University.

Hesser, Wilfried (2010) *Standardisation and how to teach it.* Lecture held at the Standardization Education Forum at Hotel Santika. Jakarta, 2010-11-03.

Kim, Danbee (2008) *Standards education in Korea – From Kids to CEOs.* Lecture held on the ICES Workshop on Global Perspectives and Strategies for Education about Standardization. Gaithersburg, 2008-02-22. http://ts.nist.gov/Standards/upload/ Standards_Education_in_Korea_From_Kids_to_CEOs_Danbee.ppt (Visited 2011-05-29).

Krechmer, Ken (2007) *Teaching standards to engineers.* In: International Journal of IT Standards and Standardization Research, 5(2), 1-12.

KSA (2003) *International workshop to develop a standardization education model.* Proceedings. Seoul: KSA.

Kurokawa, Toshiaki (2005) *Developing Human Resources for International standards.* In: Science & Technology Trends - Quarterly Review, 5(17), 1-10.

Lee, Gye-Hyung (2007) *Universities in the Republic of Korea: Training the next generation of prefessionals.* In: ISO Focus, 4(11), 17-18.

Mijatovic, Ivana (Ed.) (2010) *Proceedings 7th International Conference "Standardization, Protypes and Quality: A Means of Balkan Countries' Collaboration"*, June 8th – 9th 2010 Zlatibor, Serbia, Belgrade: University of Belgrade, Faculty of Organizational Sciences.

NEN (2010) *Annual Report 2009 – Crisis & Control*. Delft: NEN.

Nonaka, Reiko (2010) *New approach on the pedagogy for standards education: A case of Applied Standards Education at TUAT.* In: *Proceedings of International Symposium on Standardization Education and Research 2010*, 2010-03-19—20, 156-167. Hangzhou,

China. Hangzhou: China Jiliang University/Tokyo: Tokyo University of Agriculture and Technology.

Orgalime (2010a) *Draft Orgalime comments on EP IMCO report on the Future of European Standardization*. Position paper. Brussels: Orgalime.

Orgalime (2010b) *Review of the European Standardization system*. Position paper. Brussels: Orgalime.

Schoechle, Timothy (1999) *Toward a Theory of Standards.* Proceedings of the 2nd Interdisciplinary Workshop on Standardization Research, 85-95. Hamburg: Helmut-Schmidt-University.

Serenkov, Pavel (2010) *Belarus – Training tomorrow's experts today*. http://www.iso.org/iso/iso-focus-plus_index/iso-focusplus_online-bonus-articles/the-2009-iso-award/2009-award_belarus.htm (Visited 2011-05-29).

Song, Mingshun (2007) *Guest View*. In: ISO Focus, 4(11), 4-7.

Spivak, Steven M. & Kelly, William E. (2003). *Introduce strategic standardization concepts during higher education studies … and reap the benefits!* In: ISO Bulletin, *34*(7), 22-24.

Susanto, Agus (1988) *Methodik zur Entwicklung von Normen*. DIN-Normungskunde Band 23. Berlin: Beuth Verlag.

Tanaka, Masami (2011) *Cooperation between standards bodies, academia and professionals from companies in Japan*. In: Lin Jianzhong et al. (eds) *Proceedings of ICES Workshop and WSC Academic Day 2011*. Hangzhou: China Jiliang University, pp. 13 – 21.

Van Klaveren, Susan & Oostdijk, Arie (2004) *Dutch standardization Awareness Project – Meta-analysis.* Leiden: Research voor Beleid.

Verman, L.C. (1973) *Standardization – A new discipline*. Hamden, CT: The Shoe String Press/Archon Books.

WTO (2005) *World Trade Report 2005 – Exploring the links between trade, standards and the WTO.* Geneva: World Trade Organization. http://www.wto.org/english/res_e/booksp_e/anrep_e/world_trade_report05_e.pdf

Yang, Youhong (2010) *China Institute of Metrology's Educational Model for Standardization.* In: China Standardization, 37(1), 15-21.