Standardization in education
- A building block for professional careers

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Summary

The acquisition of management skills during one's studies is an important career building block that prepares students for a wide range of business demands. On the job, recent graduates come in contact with standardization and standards management in a variety of ways. Companies with a standards management system and who are strategically active in standardization expect entry-level staff to have extensive knowledge in this area. However, companies who are not involved in standards and standardization have much lower expectations, as they themselves are not yet aware of how standardization can help in achieving their business goals. This paper discusses different means of qualifying recent graduates and equipping them with the skills they need to deal with standards and standardization on the job, either to function within - and perhaps even improve and expand - an existing standards system, or to set up a new system within a company.

Standards on the job

Everyone knows what a standardized product is - such as A4-size paper. However, the full benefits of standardization, the fact that standards are developed on a voluntary basis according to the consensus principle, and the strategic importance of standards for businesses, the public sector and society as a whole is less known, or in some cases, completely unknown. Standardization is a strategic element for industry and society, facilitating trade in goods and services. Standards also help disseminate technical knowledge and innovations and place them on the market more quickly, thus enhancing the competitive ability of companies at national, European and international level. This also supports the integration of entire economic areas such as the Single European Market.

Applying standards in the innovation process also brings many advantages, for example by accelerating the transfer of R&D results into practice. This is important for all involved, because industry can amortize R&D costs early on, and users always have access to state-of-the-art technology. Standards and specifications also give companies investment security. However, the most significant benefit of standardization is creating markets for and opening up markets to
innovations. This is particularly so for international standardization and provides small and medium-sized enterprises (SMEs) with an essential tool [1, 2].

Ideally, therefore, in professional practice a thorough knowledge of one's subject should be supplemented by knowledge of how that subject is integrated into important interdisciplinary areas; this is essential for a clear understanding of actual company structures. Functions within specific areas of a company (e.g. in design, production, quality management, purchasing, logistics) are always embedded in several cross-disciplinary activities, the interrelation of which is, as a rule, highly complex. As is the case with the application of standards, strategic standardization begins long before, and continues long after, the product development process [3]. The initial training, motivation, qualification and interests of an entry-level staff member are decisive for the development of necessary cross-process skills. However, the way in which standardization and the use of standards influence processes is not sufficiently recognized and supported by most companies. This is an opportunity for young graduates to fill this gap and to develop this area in the company's interest.

On today's globalized markets products and services must not only fulfil their functions safely and cost-effectively, they are also inextricably integrated into rationalization, compatibility, quality, safety and information networks. Knowledge of these structures and methods is a valuable additional qualification for every employee. The consensus-building process in standardization is especially interdisciplinary, and the diverse composition of standards committees and working groups, who have different objectives, requires a high level of social competence on the part of the experts participating. Thus, standardization is not only an instrument for increasing the competitive ability and marketability of products and services in all economic areas across the world, but also contributes to the development of technical and social skills and the extensive networking of all participants [4 – 8].

Standardization is an interdisciplinary task which - when actively pursued - leads to the streamlined management of a company while at the same time optimizing market access for its products or services. Furthermore, standardization is an important means of ensuring that products and services on the market fulfil all legal requirements regarding issues such as liability, CE marking, conformity declaration and compliance management. Although the application of standards is voluntary, their use becomes legally binding when they are part of a contractual agreement between parties, or if legislators stipulate conformity with them. It is therefore important for companies to obtain as early as possible information pertinent to their interests that could have an effect on their business processes, and to act accordingly. Business managers must act in compliance with the law and all legal provisions [9].

Various platforms such as DIN's DITR database, the Perinorm standards management solution, Beuth Verlag's "Standards Ticker" updating service, and numerous online portals provide users from all companies and all sectors with access to standards, helping them integrate standards into their own organizational processes [10, 11]. The relevance, application and implementation of standards depend on the specific requirements for the relevant sub-process. The economic relevance of applying standards for business purposes is often underestimated due to a lack of knowledge [12]. In this matter there is clearly a need for increasing awareness, improving training opportunities, and promotional work [13].

Such an increased awareness is thus clearly needed in the area of academia and training, and knowledge of the impact of standards and participation in standardization must be disseminated. This requires the broad support of a large number of professors at all universities.
Standardization and education

According to a survey of university and college professors - to whom relevant course materials were sent - there is a general interest in including standards and standardization in academic curricula. Some of their responses were as follows:

(From the cover letter sent with the survey from 2010): "Future engineers will have to deal with standardization and European legislation in their work; these subjects are not always sufficiently dealt with in academic curricula. Also, few are truly aware of the relationship between standardization and innovation. Standardization, law and the use of standards are only dealt with when the professor is active in standardization (and this cannot be said for many). It is well known that many academic institutions have access to standards (via digital repositories such as the standards database "Perinorm"), but most students do not know when and how a document should or must be used. ... I urge you to incorporate this important topic in your lectures, for these days it cannot be considered by industry as only a "side" issue. Because of their international and legal significance, standards and their use have become top priority for management.

Some responses:

- "... I have received the course materials, can certainly use them and will do so."
- "...first, thank you very much for your initiative, which I consider as being truly necessary. Why? In a few words: product conformity."
- "...many thanks for your information ... I fully agree! I will use these materials in my lectures on design engineering."
- "... the attached course materials can be used in the course on design engineering and can replace the few slides we have ... we plan to modify 1-2 courses accordingly."  
- "... There is indeed a need for action and I will incorporate this important information in my lectures."
- "... I agree that this subject does not receive enough attention in education and will definitely address the subject ... more often."
- "...Directives which play a crucial role in medical technology (medical devices legislation, EU Directives) describe to a large extent procedures and methods. However, in my lectures on machine elements I have not sufficiently dealt with standards until now."
- "...The presentation [course materials] is now on our server and I will encourage my colleagues who lead our six groups of first-semester students to use them."

Although we welcome these positive reactions, there is still no indication that standardization is being integrated across the board into the curricula of all institutions of higher learning. As can be seen in Figure 1 there are still many "blank spots" on the map.

DIN introduces students to standardization in guest lectures held by top-level staff from the DIN Group as part of regular courses on various subjects. Lecturers come from all areas covered by the 70 DIN Standards Committees (see www.normung.din.de). Some professors, such as Prof Müller of the Institute of Mechanical Engineering at the Clausthal University of Technology (CUT), integrate standardization into their courses. Dr Hartlieb, a former Division Head at DIN, also teaches a more in-depth course on standardization at the Clausthal University dealing with standardization as an instrument for increasing competitive ability and marketability. This course has been offered from the 2004/2005 winter semester (WS) and is compulsory for business students and an elective for students of all other subjects. The course, which concludes with an oral exam, is held every semester as an advanced course.
Furthermore, Dr Thies of the DKE (German Commission for Electrical, Electronic and Information Technologies of DIN and VDE) holds a course at the RWTH Aachen University on safety measures and safety equipment in electrical networks and installations. Dr Dreger - likewise from the DKE – lectures on electrotechnical standardization at the TU Darmstadt.

"Strategic standardization" at the TU Berlin

Motivation
Up to now, the broad spectrum of ways to participate in standardization and for applying standards as described above has not been dealt with very systematically in academic curricula. But because it is so strategically important for industry and society as a whole, standardization is of interest to students, particularly management and engineering students [15].

Course objectives
Students attending the course learn how national, European and international standards are developed and about the role of the stakeholders in standardization. They learn how standards promote deregulation, particularly the relationship between harmonized European Standards and EU Directives as prerequisites for CE marking. The differences between standards and patents are clarified, as is their role as instruments for bringing technological innovations to the market. Furthermore, students learn methods for determining the macro- and micro-economic benefits of standardization. Through numerous practical examples - and through practical experience gained in the associated tutorial - this course provides students with a thorough understanding of the interdisciplinary interaction between legislation and technology, and shows how they can be used not only to strive towards a higher quality of life, a more efficient use of resources, greater equipment and product safety, but also to protect the environment. Through this course students gain skills that will not only provide a good foundation for their work in companies and corporate decision-making, but can also be used in academic research.
Attention has been given to standardization especially in courses at the Technical University of Berlin (TU Berlin), in most cases with the involvement of DIN staff. Currently, the “Strategic standardization” course is being offered with the participation of many experts in standardization, including DIN staff members. Held for the ninth time in a row, this course has always been well attended, with more than 40 students enrolling per semester (Figure 2). One decisive factor for the success of this course is the large number of guest lectures by specialists from industry, research, the public sector and other organizations involved in standardization who illustrate the principles taught in the course by providing practical examples. The extremely practical tutorial includes participation in standards work at DIN and related events. Thus, students not only gain theoretical knowledge relevant to standardization, but practical experience as well by observing the consensus-building process first hand. Students attend meetings of DIN's working bodies that develop documents at national, European and international level, as well as workshops, seminars and DIN Conferences. Upon successful completion of the final exam the "DIN Standardization Expert - Module I Principles of standards work" certificate is awarded.

Once a year this course is also offered in English as part of the TU Berlin's "GPE – Global Production Engineering" study course. This enhances awareness among German students of the global relevance of this topic, while at the same time introducing standardization to foreign students as well.

The course is made up of 9 modules

1. Introduction to the significance of standardization as a strategic instrument
   This module gives an overview of the development, significance and content of standards and specifications in a variety of areas. The organizational structure of DIN, the principles of standardization, and a general overview of the following modules are covered. The role of public and private organizations and the deregulatory nature of standardization are emphasized.
2. The standardization process and participation in this process
Beginning with a description of the different types of standard and their characteristics, this module goes on to discuss the development and benefits of standards and specifications in general, as well as means of participation in standardization at national level.

3. International and European standardization
The aims and advantages of European standardization, and its role within the European legal framework, such as the New Approach, are clearly described here. Further, the structures of the European and international standards bodies are described, and the role of the national standards bodies in the development of European and international standards is illustrated.

4. Product conformity and CE marking
This module gives an overview of the procedures within a company for ensuring product conformity, including the role of CE marking. The manufacturer's obligations and liabilities are discussed in detail, giving practical examples of product conformity, organizational requirements, and responsibilities within a company.

5. Standardization as a means of deregulation and contract security
How standards help deregulation is illustrated by showing the role of technical standards within the legal framework in general and in European legislation in particular. The module concludes with a description of how standards are used as a contractual basis and of their relationship to - and differences from - patents.

6. Standardization as a means of giving detail to general protection targets (e.g. environmental protection, occupational health and safety)
Technical legislation such as laws, regulations, and directives, and the use of technical rules such as DIN, DIN EN and ISO Standards, and VDI Guidelines for decision-making and as sources of information are covered. This module shows how standards give detail to public sector protection targets in areas such as occupational health and safety. A focus is placed on social responsibility for organizations as described in DIN ISO 26000.

7. Standardization in research and development: Innovation with norms and standards
The role of standards and specifications in the R&D process is illustrated by means of examples. The need for standardization in innovative fields is discussed, and relevant national and European funding programmes and projects are described.

8. Standardization as a strategic instrument
This module describes the German Standardization Strategy, its incorporation into the standardization strategies of industry associations, and its integration into the "Standardization Policy Concept" of the German Federal Government. Its close connection with standardization strategies at European and international level is also described. Furthermore, the relationship between standards and patents is explained, as are strategic possibilities for using both of these instruments of technology transfer.

9. Economic benefits of standardization and benefits for business
Here, the economic benefits of standardization are illustrated by means of numerous examples. For the purposes of this module, standards are categorized according to the types of benefit they bring, and examples are given of the different tools used at national and international level for evaluating the benefits of standardization.

In addition to guest lectures at colleges and universities and the course “Strategic Standardization”, students are also invited to informative events held at DIN on various topics of interest. At DIN they are also introduced to the very modern working conditions for DIN’s more than 150 project managers.
Introducing students to the world of standardization

DIN's "studiFORUM" series of events unites innovative and business-oriented topics with the benefits of standardization, and is aimed at students and recent graduates in all areas of study. During these events students attend practically-oriented lectures, discussions and workshops, and exchange ideas on many topics, coming together with top business experts and DIN staff in a relaxed atmosphere.

The first studiFORUM event, dealing with electromobility, was held in May 2011. It met with great success from the very beginning, gaining attention not only from students but from industry as well. So far there have been six events in the studiFORUM series (Figure 3):

<table>
<thead>
<tr>
<th>Event</th>
<th>Date</th>
<th>Topic</th>
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<tbody>
<tr>
<td>Electromobility</td>
<td>May 11</td>
<td>Electromobility</td>
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<tr>
<td>Offshore wind energy</td>
<td>Nov 11</td>
<td>Offshore wind energy</td>
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<tr>
<td>Managing safety</td>
<td>Jan 12</td>
<td>Civil security</td>
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<tr>
<td>Aviation</td>
<td>June 12</td>
<td>Aerospace</td>
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<tr>
<td>The rail industry</td>
<td>Nov 12</td>
<td>Rail industry (Berlin)</td>
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<tr>
<td>Offshore wind energy</td>
<td>Nov 12</td>
<td>Offshore wind energy (Hamburg)</td>
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At the six studiFORUM events more than 350 students discussed their questions with experts and made personal contacts. Top industry gained an increased awareness of standards and standardization and could be recruited for participation in standards work. By using practical examples to illustrate the benefits of standardization, the studiFORUM series helps increase a positive awareness of DIN and its work among this young target group. Furthermore, over 100 students have subscribed to our studiFORUM newsletter and have thus remained in contact with DIN. studiFORUM has received a positive response from students and industry representatives alike and provides a platform for conveying the benefits of standardization to students as well as lecturers. For more information visit the studiFORUM facebook page or www.studiforum.din.de.
Conclusion

A number of initiatives are encouraging the integration of standardization into curricula. There are many reasons why academics and researchers should incorporate innovative topics into standardization, such as:

- Exchanging knowledge with national and international researchers
- Expanding one's own network to European and international level
- Incorporating one's own research findings into future standards
- Exchanging information with industry representatives, manufacturers, users, and the public sector in order to identify research priorities
- Promulgating one's own research activities among potential clients in the public and private sectors, as these take part in standards work
- Using standards work as a source of information on new research being carried out
- Gaining access to funding programmes and applying for funds
- Enhancing one's reputation by participating in national, European and international standards bodies

The Deutscher Förderverein zur Stärkung der Forschung zur Normung und Standardisierung e.V. (FNS) (German Society for the Promotion of Research on Standardization) provides a wide network of contacts who implement the results of standardization [16]. Standards and standardization are also covered in detail in some standard textbooks and reference works, such as [3, 17, 18].

In 2017 DIN will celebrate its 100th anniversary, evidence of the success of our work. At national, European and international level DIN has always successfully met new challenges, advancing the interests of German industry. The continual emergence of new areas means there is a recurring need for new standards and specifications. German industry makes good use of DIN's services - and DIN itself employs qualified young graduates and experienced experts [19].

To make its exceptional services well known to economic operators and business leaders of the future, DIN needs to make contact early on in their professional careers. The efficient structures of international standardization - and DIN's leading role in the international arena, even in the development of non-formal standards - are being effectively disseminated among students through DIN's activities. However, more support is needed from professors so that the number of lecturers who include standards and standardization in their teaching will increase.
Bibliography

Recommended literature
An introduction to standardization does not necessarily have to be heavily theoretical, as is shown in the following German-language publications which give a brief, easily understood overview of the subject. These publications are particularly addressed to SMEs as this group has expressed a particular need for more easy-to-understand information on standards and their use.

**Kleines 1x1 der Normung – Ein praxisorientierter Leitfaden für KMU [20]:**
(Introduction to standardization - A practical guide for SMEs)
This brief guide explains the basic terms and procedures relating to standardization, especially as regards the participation of SMEs. A focus is placed on encouraging the involvement of industry associations and chambers of trade and commerce, with the aim of getting small businesses more active in standardization.

**Normung und Standardisierung – Grundlagen [21]:**
(Principles of standardization)
Intended as a reference work and textbook, this title describes how standards are developed at national, European and international level and how to participate in this work. The connection between standards and statutory provisions such as laws, regulations and EU Directives, and the deregulatory effect of standards, are dealt with in detail. The use of standards in contracts, liability issues and other routine legal business are also addressed. The book also illustrates how innovation and standards do not contradict, but effectively complement, one another.

**Normen richtig lesen und anwenden – Erläuterung anhand von Beispielen [22]:**
(Correct interpretation and application of standards, with examples)
This compact book gives standards users guidelines for correctly selecting, applying and understanding standards, avoiding misinterpretations. The different types of standard and their structures are systematically described using examples. Elements such as amendments, patent statements, normative references, annexes etc. and their relevance are explained.

**Umgang mit Normung und Normen – Broschüre mit Handlungsempfehlungen und Umsetzungsbeispielen [13]:**
(Standardization and standards - Recommendations and implementation examples)
This study discusses how the needs of SMEs can be taken into consideration in the development of a standard. The rules of procedure and principles of standards work are examined in light of the needs of small business. How SMEs apply standards, and under which conditions this application can be improved, are also addressed.

**Produktnormformität und CE-Kennzeichnung - Wer ist im Unternehmen verantwortlich? [9]:**
(Product conformity and CE marking - Who is responsible in your company?)
This title from Beuth Verlag's "Pocket" book series clarifies who is responsible in a company for conformity declaration and CE marking, specifically the responsibilities of management, sales departments and product developers. Case examples are given illustrating these responsibilities. Being practically oriented, this book is ideal for use in lectures and seminars on the subject.

Further information is available for free via the Internet; see the list of cited literature. In some cases, the websites are also available in English.

Literature cited


