

Teaching Standards in Higher Engineering Education – Necessity, Objectives and Approaches

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In the presented report, through in-depth study of international researches, the importance of standards in all areas of life and pressing need to deepen the study of standards in the higher engineering education has been reasoned.

Results of a questionnaire survey have been stooped, with respondents - engineering students, confirming their awareness that enhanced study in the field of standardization is needed. Education about standards and up to date information about them is condition for improving the quality and effectiveness of their study.

The authors propose a comprehensive approach to education about standards, which includes complementing of the curriculum of technical subjects and creation of new discipline that studies standards used in the particular specialty and those found in everyday life.

Positive contribution to the creation of good qualified engineers has access to updated information about standards, which would be achieved through the establishment of an Information Centre at campus in constant contact with Standardization Institute.

Key words: Standardization, higher education, engineering education, teaching program, survey.

1. REVIEW OF THE PROBLEM

Standardization is a key factor for the integration of a national economy into the world market, which ensures uniformity of product requirements, production conditions and procedures for assessing compliance, thus achieving free movement of goods, people, capital and services worldwide. Compliance with endorsed norms and standards results in improved living conditions through the provision of security products and services, protection of health and life of humans, animals and protection of the environment. Therefore, for proper realization of young people in a market economy, it is essential that in the learning process at all levels information about standardization and training, which creates knowledge and skills to work with standards, is included.

This concerns even more engineering students because most of the technical knowledge is regulated and standardized. Understanding the local, national, European and international technical standards and information for their update, is imperative to improve the quality and effectiveness of engineering education. As future professionals, producers and consumers students should realize the social significance and role of standards. Future engineers have to be aware that applying standardization would improve the quality of their product or service. High quality is always a very strong argument for the production sale and it is one of the best ways to create permanent customers. To attract new customers, standards are one of the most effective methods of persuading consumers because the product meets the highest and most common requirements for quality, safety and security. Protecting the safety, health and welfare of the public is part of the Code of Ethics for Engineers. The application of standards plays a major role in satisfying this.

The application of standards enhances competitiveness by offering high quality product of labour. The young engineer should know that the application of technical standards ensure its competitiveness, maximize the potential market and is an advantage in export of products. Although standards are voluntary and not required by law in some markets the output will be accessible, unless it meets certain criteria of quality and safety. The application of certain standards as related to environmental protection, help to build a reputation in the community.

Standards provide young professionals a safe starting point, which reduces the risk of mistakes and misunderstandings and this good practice decreases wasted time and money to develop products that do not meet the necessary quality requirements. Application of technical standards reduces costs for research and development [3, 4].

Young specialists have not only to learn the benefits of applying the standards during their higher education, but also how to access them. They have to become familiar with the activities of the standardization institutes in the country, in Europe and worldwide. They have to learn how to receive timely information on new introduced, changed or updated standards.

1.1 Perspective of both educators and business representatives

In this part of the report, the authors reviewed the research and publications on the subject matter of standardization institutes, universities and industry from different countries.

For example, in 2005, US Congress estimated that private sector standards and government technical regulations directly affected at least \$7 trillion (US) of world trade in 2003. In UK National Standards Strategy (2003) is written- Standards influence everything we do. Standards control markets (German National Standards Strategy (2005)). According French Standardization Strategy (2006) - Standardization is one of the most powerful sources of competitive economic intelligence available.

In American Society of Mechanical Engineers they believe that standards must be integrated into engineering and engineering technology courses, be a part of design and manufacturing-oriented competitions, and be embraced by faculty as important to preparing students as practitioners. The course exposure must include both national and international standards such as those from ISO, IEC, and ASME, because of the global nature of engineering.

BSI British Standards states that the continued success and development of the UK economy has a need for students to understand the significance of standards within it. Standards form a common language, a dialogue in which all can participate and from which all can benefit. The key benefits of developing a strategic education plan, nationally or internationally, are numerous: raising awareness from a young age of the benefits and uses of standards; influencing future participants in standards creation and future purchasers of standards; furthering the research base on the impact of standards.

Like industry representatives, CSK Holdings Corporation note that the effect of the quality and quantity of the output of an education program is profound and wide, and its results may affect the society and its economy for many years. They say that standards, especially global standards have strategic value in the sense that they affect not only the current marketplace or product/service production, but also the industry and government planning because they will promote the specific lines of products/services that conform to the standards.

The Institute of Electrical and Electronics Engineers expose the opinion that technical standards are consensus documents that define the solution of complex technical problems taking into account economic, ethical, and societal constraints. A large part of the world's trade today involves products that comply with one or more standards. This has made education about standards, both at the college level and among the workforce, of significant importance. At the same time education about standards faces significant challenges. These challenges include increasing technology complexity and rapid evolution of standards.

While the critical role of standards is generally recognized, surprisingly little has been reported about the critical role of standards education. Not only are standards of critical importance, but standards education is of strategic value to industry and the society.

Behind a winning standards strategy there are well-trained and experienced technologists and marketers who have mastered the art and science of standards in industry. Most often, these employees have learned the practice of standards at best, from a company mentor or at worst, by trial and error. It can take many years of "on-the-job training" for a professional who is unfamiliar with standards to become fully proficient.

Standards education programs are handicapped. As of today, in most countries standards education programs do not have solid departments or institutes to provide educators a framework within the educational institutes. Stand-alone courses in standards exist in a few universities, but the occurrence is rare [1, 2, 5, 7].

Lecturers in engineering fields reported that engineering knowledge has normative component that lacks in pure scientific field and that is why students studying engineering are in need of studying and knowledge about standards and other normative documents as an integrated part of the education that future engineers and technologists are expected to receive.

It is recognized that this complex issue is not resolved in the present education and there are not adequate curriculum that includes training in standardization.

1.2 Exploration of students' opinion about their training in the field of standardization system and standards

At the beginning of their engineering studies students face standards. A large part of the learning content of the fundamental subjects in the basic module is standardized.

The authors aim to investigate, through inquiry, the opinion of students on obtained knowledge in the field of standards and the need for their expansion.

University of Ruse (RU) follows the standards and guidelines for quality assurance in the European Higher Education Area. Traditional practice in the University is to seek feedback from students through surveys. This is an effective tool for managing the quality of education.

The report provides the results of a survey conducted at the Department of Mechanics, Machine Elements and of Engineering Graphics in RU. The purpose of the questionnaire is to receive updated information about the students' perspective on the need to enhance their culture and awareness in the field of standards and the structure of the standardization system in Bulgaria.

a) Structure and content of the survey

When developing the survey authors draw on their previous experience in conducting surveys among students, and on the practice of other universities abroad. The survey is structured in three parts.

The first part is introductory and provides information on the location, timing and the respondent.

The second part is the essence of the inquiry. The proposed questions covered some main topics:

- knowledge about the standardization system obtained in previous education;
- their experience in searching and using the required standards in their education and practice;
- availability of information related to standards;
- their appraisal of the need to introduce;
- adding topics in their training program and set up a complete course of a discipline that acquaint them to the standardization system and required standards.

In the third part is given place where students could expose their comments and recommendations on the subject of the inquiry.

b) Carrying out the survey

The survey was conducted with students from the fields - Mechanical Engineering, Transport and Agricultural equipment, taking courses at the Department of Mechanics, Machine Elements and Engineering Graphics at the University of Ruse.

Students- participants show interest in the topic and willingness to answer questions because they realize that they can help to improve the learning process.

c) Survey results

The responses in the survey show that students have met standards both in training and in practice.

38% of respondents are aware of insufficient information about existing standardization system and current standards.

They appreciate that in the already attended courses at Ruse University attempt to give full and updated acquaintance with standards related to specific subjects.

However, 80% of them think that, a broad and in-depth information about standards in each discipline is needed.

84% of students- participants are likely to choose attending of a separate subject giving them a wider culture and deeper information about standardization system and guidance how to access it.

Over 90% of students want the existence of an information center at the University, connected with Bulgarian Institute for Standardization (BIS), which will give regulated access to standards related to their specialty.

Following the analysis of the results of the questionnaire, the authors propose a new approach to training in the field of standards in higher engineering education.

2. A NEW APPROACH TO TEACHING STANDARDS IN HIGHER EDUCATION

From the publications and research review of different international institutions on standards, and the opinion of engineering students the authors came to the conclusion of the pressing need for new approach and new curriculum includes topics for standardization system, standards and how to access.

Up to 90's the structure of the standardization system in Bulgaria is nationally oriented and closed. At that time standards are distributed only on paper, though information about them entered regularly all institutions. Each department at the university maintains a library with standards in the related field. Gathering data from a large number of standards in reference books is useful practice for industry and students.

Nowadays, after the changes in the bodies responsible for standardization a shortage and difficult access to new and updated standards is perceptible. Although today the standards are not mandatory and BIS is not a state institution the need for better information about standards and better access to them is recognized by higher education and in particular in Ruse University. Therefore, it is essential to find the right form and to create a curriculum to give students about standards and about the positives of their knowledge and application.

For now the most common practice is to introduce the teaching content that includes standardized information, without students to be aware that these rules and requirements are imposed by the standard.

The authors of this report propose a more comprehensive approach to the teaching content associated with standardization.

2.1. Complementing the teaching content with exact information about related standards

As a first step, to each discipline associated with standardized content to provide clear and accurate information and if it is possible to cite the standard and to provide information for its relevance to older and harmonized standards.

In this way students will realize that this learning content is standardized and this rules and requirements is important to be followed.

In each discipline curriculum there should be at list a topic associated with the relevant standards for the contents of the course.

Good practice is the teacher to prepare reference material with excerpts from the relevant standards applicable in the course. This will help students to develop skills to work with standardized information and apply them to solve complex technical problems [6, 8].

2.2. New subject concerning standards

The authors propose establishment of a new subject related to the education about standardization. This subject will be placed in the curriculum at the beginning of the base module. The syllabus of this subject will provide content which includes some main themes, listed and described below.

In the course students' attention will be drawn to the fact that standards are all around us. In everyday life, we encounter this phenomenon when we use products and services without even realizing it.

In the introductory theme will be highlighted the social importance and role of standards and will justify the need of knowledge about them and their application. This will be explained with clear and motivating examples.

The new subject will provide information about standardization system, BIS, different types of standards – national (BDS, DIN), regional, European (EN) and international (ISO). Students will be taught how to access standards and relevant institutions and about the reference books available.

Students will examine the theoretical basis of creating standards, from the occurrence of the need for establishing standards to their adoption and implementation. They will learn what the national and European institutions for standardization are responsible for and about the links between them.

It is important that students will get acquainted with national and regional policies and standards. Markets are increasingly becoming international, reflecting the globalization of world economy. Regional and international standards support globalization by facilitating entry into international markets through compliance of their requirements. They increase accessibility to the market and remove barriers to trade by showing that local requirements are met. Harmonized standards provide greater opportunities for companies to sell internationally.

The next issue is devoted to the use of specific widely used standards. For example:

- Quality management systems - Requirements (ISO 9001:2008)
- Environmental management systems - Requirements with guidance for use (ISO 14001:2004)
- Guidance on social responsibility (ISO 26000:2010)

The new subject will provide specific information about standards relating to the studied specialty. Students will become acquainted with the specific standards concerning themes chosen by the companies requiring specialized training.

Segmented in this way the teaching program for the new subject will provide a full knowledge about standards and their application and would be extremely useful addition to their higher education.

2.3. Establishment of an information center - a direct link between the university and standardization institute

BIS follows trends in the European standards institutions in realization of closer links with universities. [10]

This strategic objective of BIS will be fulfilled by creation of an information center linked and accessed over Internet with regulated access for students and teachers. The center will allow controlled information about standards related to the scientific areas covered in the university. The system developed will be from a great help to students, graduates and faculty, and to the needs of the public.

Some universities, including the University of Ruse stated their desire to build such a center [9]. The first contacts are made and actions have been carried out.

CONCLUSION

An analysis of the problem for the training about standards in the higher technical school has been made by investigating the opinion of international institutions (standardization institutes, universities and companies) and the need to strengthen and systematize the curriculum for studying the standardization system and learning specific standards linked to the respective scientific field has been revealed.

A survey has been conducted with participants-students at the University, which allows the conclusion that they realize the importance of standards, both in their education and practice and are willing to expand their knowledge in this area.

Based on these studies and on their personal experience the authors propose a new approach to the study of standards and standardization, developed on three levels:

- Implement further topics for standardization in each subject;
- Introduction of a subject about standardization system, standards applicable in everyday life, as well as specialized information on standards related to a particular scientific field;
- Establishment of an information center for a direct connection between the university and the standardization institute. The center will offer updated information on standards.

Awareness of the importance of standards and of the need to include learning content about standards in higher education requires an appropriate approach. It is necessary to facilitate access to standards and to the timely information about their renewal.

Very useful would be if the relations between universities and standardization institutions deepen. It could be managed through creation of information centers for permanent connection on campus as well as regular receiving bulletins for news about standards related with the certain scientific field. Good practice would be implementing reference books concerning such standards.

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Докладът е рецензиран.