Industrial Standardization and Higher Education: 
Current Supply vs. Industry Demand

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Abstract

Many of the products and processes that humans consider everyday conveniences would not be possible without standardization. The majority of the standards that have made today’s technology possible were approved by engineers and technologists over the past few decades, many of whom are of the “baby boomer” generation and presently on the brink of retirement. Consequently, a growing concern exists among standards professionals in the United States about how well-versed the next generation of engineers and technologists are on both the process of standardization and the economic benefits companies can attain by utilizing and developing standards.

In recent years both standards developing organizations and educational institutions have attempted to alleviate the dearth of standards education by developing multidisciplinary curricula directed toward advanced education on standardization. In addition, studies have been conducted within academia to determine the current use of standards in the classroom. Obstacles such as a lack of qualified instructors, curriculum ‘bloat’ and limited funding are some of the issues cited as preventing more wide-scale implementation of standardization courses in colleges and universities. This issue crosses all disciplines, both within the engineering community as well as science, law, business and others.

To further define the granularity of standards education in engineering, a 2009 research project to determine both the demand by industry for engineering practitioners possessing standardization skills, and knowledge prior to employment, was initiated by Purdue University. The study also investigated the potential for industrial collaboration with local colleges and universities to establish courses on standardization. Results suggest that managers tend to recognize standardization as an essential part of daily operations and feel that such courses would be beneficial to future employees. However current economic conditions prevent many companies from allocating the necessary funding to assist in the creation of such curriculum. This paper discusses results and preliminary analysis of the Purdue study and suggests opportunities for engineering and technology based on the results.

Standards today

Engineering and technology practitioners of the ‘baby boomer’ generation are generally the standardization experts of today. As that generation begins to retire, there seems to be waning
interest among recent engineering or technology graduates to fill the looming void in standardization expertise.

Despite the daily interaction humans have with standardized products or processes, rarely is the time taken to consider the various standards that form the foundation of products and processes development, let alone why such requirements are even necessary. For example, without standardization, communications among cellular phones across different carriers would simply not be possible. Yet users just assume the phones will work. Is this lack of knowledge about the importance of standardization hindering both new creation and innovation within American companies? In order for innovation to occur, it is imperative that one not just accept items at face value, but rather continually question the specifications and processes that go into developing such items. Despite this apparent lack of interest, standards continue to affect every aspect of today’s society and economy, from basic electronic devices, to the financial sector, and global trade.

Only in recent years have United States standards professionals developed a growing concern regarding the lack of student exposure and knowledge about the use, implementation and development of standards. In August 2000, the United States Standards Strategy (USSS) was formally approved by the American National Standards Institute (ANSI). Increasing educational awareness about standardization is one of twelve primary objectives of the USSS (1). To that end, over the past several years standards professionals have conducted studies to determine how professors are incorporating standards into current curriculums. In parallel, other attempts have been made to increase students’ awareness of standards by imposing minimal requirements for standards use within specific engineering and technology ABET requirements. Yet the question of how to adequately implement the practice and application of standards into curriculums still remains largely unanswered.

Among standards professionals attending the 2009 “Promoting Education about Standardization” forum held at the National Institute of Standards and Technology (NIST) campus, one common suggestion was to offer a multidisciplinary course to expose students to both a variety of standards and procedures within standards development organizations. While the need for such a course was generally agreed upon, the question of specific techniques for integrating such a course was avoided. This was due to the practical difficulties created by attempting to add courses to curricula already overflowing with required courses. Thus, despite efforts to increase education about standards, it is recognized that progress will be slow.

Another technique posed was that of incorporating standards-based modules throughout multiple courses, negating the need to add credit hours to already bloated curricula. This too was seen as a positive approach, but the development of, and access to sufficient discipline-specific course material was seen as a major hurdle.

Educational offerings

Compared to other developed countries, the United States seems to be far behind in developing a required standards curriculum appropriate for all ages. Europe and Asian countries such as
Japan, China, and Korea, have already discovered the importance of standards education and are now seeing benefits of implementing standards-awareness courses into all levels of education, including grade schools (2). Among implementers, it is felt that through early awareness of the importance of standards, students entering the workforce within these countries will become an essential asset to companies in a growing global economy. Examples of the international education courses include the “87 standardization courses held at 46 Korean universities” in 2006 in which “were attended by 6,681 students”, the Asian Link Project on Standardization Education, and a “secondary school program on standardization education in Thailand (2003-2006), where 2,354 teachers were trained and 444,600 students received standardization education” (2). However among these success stories, there are major roadblocks when considering these approaches in the United States. Among these is the complexity of the US decentralized standards system and the lack of government funding commitments enjoyed by other countries.

Currently within the United States, there are very few avenues to standardization education. These include either on-job training sessions, typically to specific standards, a general course held by a major standards development organization (SDO), or enrolling in specific graduate courses at one of the four universities (The Catholic University of America, University of Colorado at Boulder, Purdue University, and the University of Pittsburgh) (1). At this writing these universities are the only US institutions that offer courses dedicated to advanced knowledge/understanding of the standardization processes (American National Standards Institute, 2009).

While on-the-job training is currently the main method for engineers to advance their standards education, the opportunity may not be available to all employees. In addition to ANSI, most major SDO’s, such as IEEE (The Institute of Electrical and Electronics Engineers), ISO (The International Organization for Standardization), and ASTM, Inc. (formerly the American Society for Testing and Materials), ASME (American Society of Mechanical Engineers) offer online and on-site training as well as educational resources such as case studies and tutorials for the average individual interested in standards education. While the above named universities offer courses specifically on standardization, these courses are neither required for, nor target, undergraduate students. Other, more generalized, standards resources that are available to the public can be found at www.standardslearn.org, www.standards.gov, and www.ses-standards.org.

One reason for the lack of courses is funding. Many professionals agree that an adequate standards course would require students to have unlimited access to a standards database, which can cost tens of thousands of dollars. While there are many educational grants available, few are designed to assist in developing a course focused on standards. Without a college or university willing to absorb the cost of establishing such a course, there are very few methods of funding. Both ASTM and ISO have developed awards for educational institutions or professors who incorporate the use of standards as an integral part of classroom assignments. In 2009, ASTM introduced the “professor of the year” award in which both the professor and the university receive $2,000. In 2006, ISO in conjunction with the Japanese Industrial Standards Committee
introduced a “Higher Education in Standardization” award which includes a 15,000 Swiss francs cash prize and a publication in both ISO’s Focus Magazine and website (3).

Study methodology

In July 2009, research was conducted at Purdue University to determine both industry’s need for college graduates who possess the skills and knowledge to implement standards as well as develop standards. The research also investigated the willingness of industries to contribute to the development of a standards course at local institutions.

Since standards affect all economic sectors, from manufacturing to financial industries, a questionnaire was developed that targeted managers from multiple sectors of society, but with an emphasis on technical industries. In that effort, a survey questionnaire was sent to members of ASTM, alumni of the Purdue University College of Technology, and industry contacts as listed by the National Society of Professional Engineers (NSPE). See Appendix A. The survey was designed to target individuals holding management positions, likely the decision-makers who could provide the most accurate information regarding the company’s use of standards. However the directions allowed managers to delegate completing the survey to others who might be more directly knowledgeable about standard use and/or interest within their company. Of the approximately 13,000 individuals receiving the survey, about 550 respondents held managerial positions.

Survey results

1. Managers recognize standardization as an essential part of daily operations, regardless of the company’s economic sector.

   The survey confirms that respondents consider standards a key driving force behind their company’s growth and that employees have multiple opportunities to attend training sessions on standardization. Sixty-five percent of those surveyed indicated that there are employees in the organization who are either active participants within standards development organizations or active participants on standards committees. Additionally, ninety percent of those surveyed described standardization (company standards and/or national/international standards) as being either extremely, or very, important in the overall growth and success of the company, its processes, products, and services. Furthermore, eighty-seven percent of respondents report that the standards necessary to complete projects are readily accessible.

   However, despite this apparent understanding of the importance of standards, only sixty percent of the respondents claim that their companies offer courses or other training opportunities for employees to increase their knowledge about the standards development / standardization process. Of those who reported on-site training, sixty-one percent offer courses multiple times a year, while nine percent offer daily training. In addition, seventy-four percent of the companies offering on-site training also suggest that employees attend standardization sessions offered by external organizations. Of the respondents that indicated their companies do not offer courses and training opportunities, sixty-three percent indicated employees attend
training sessions offered by external organizations. Only thirty-two percent of those surveyed indicated that these training sessions are required for all employees.

2. **There is a need to develop more courses which incorporate standardization as part of the curriculum at institutions of higher learning.**

While an overwhelming majority (eighty-five percent) of respondents believe that current employees meet company expectations when determining what type of standard to use, how to locate the standard, and how to utilize the standard, the majority (fifty-eight percent) agree that there is a need for engineers who possess the fundamentals of standards development and the knowledge to find and apply standards prior to employment. Seventy-eight percent of those surveyed agreed that taking a standards education course in colleges or high schools which is focused on both the development and the application of standards, would better prepare graduates to work for their company. The majority (fifty-two percent) of respondents also indicated that such a course could potentially reduce the amount of on-site training. However, due to the diversity of both respondent job titles and industry sectors represented, the results strongly suggest a general need for such a course to be multidisciplinary. Company size of respondents ranged from self-employed individuals to employees of large multinational corporations.

3. **There is a significant lack of industry funding for education about standardization.**

Despite company representatives being in favor of implementing a course on standardization into higher education curriculums, only fifty-three percent of respondents felt that their company would be willing to work with local educational institutions to establish a course dedicated to education about standardization. The majority indicated that either there was little to no funding available based on the state of the current economy, or the respondent was unsure whether or not such funding could be incorporated into the company budget.

For those few individuals who suggested that their company might be willing to work with local educational institutions, funding ranged from $200 per person per session, to upwards of donations totaling $500,000. Additionally some individuals suggested rather than monetary contribution, they would be willing to assist on an advisory basis. Other suggested sources of potential funding included state and federal government grants. The lack of funding from industry or others, poses a significant hurdle to growing such courses. There is often significant expense required to making standards available to students via either outright institutional purchase or a subscription service.

**Course proposal**

Based on these results, and in order to cater to the broadest possible industry sectors, plus provide the suggested multidisciplinary classroom environment, it is recommended that standards professionals work with colleges and universities to develop a two-term “core” course for upperclassmen available to all majors. Throughout the first course, students would be introduced to the concept of standards, their economical importance, the major standards developing organizations, and the process by which standards are developed and approved. Furthermore, students would be required to select a specific standards developing organization, not covered in lectures, that relates to their major and give a presentation covering not only the
standards applicable, but also the standards development process and the organization of the SDO itself.

The second course would require more independent work by students, focusing on the application of standards. Students would be working on a term-long project, in which they select or develop a product that relates to their field of study, then research the standards applicable to the product. Lectures would be a combination of discussing the fundamental methods to find appropriate standards. Additionally, industry representatives would be invited as guest lecturers to discuss current projects that require such skills and knowledge. Through a paper and presentation, students would present their findings and provide detailed explanations of why such standards were necessary for the product to operate efficiently and effectively.

To further validate their knowledge, it is proposed that after completion of these courses, students who demonstrated a high level of knowledge about standards be given a pre-certification in standardization. Perhaps this certification could even be based on existing standards certification programs offered by one or more SDOs. This certification should provide an incentive for students to continue their education about the standardization process. By developing such a course, students would not only be exposed to a variety of standards from multiple fields of study, but also become more knowledgeable about how standards are integrated into everyday products and processes which drive a global economy.

**Industrial and educational collaboration**

Based on the survey results, a challenge must be presented to both industrial and educational institutions. Institutions of higher learning are seen as the stepping stone for students prior to entering the competitive work force, providing the knowledge and skills one needs to be an important asset to future employers. It therefore is essential for schools to continue to build relationships with businesses from all economic sectors, developing curriculums focused on common educational goals. Standards are obviously a primary part of any business and if colleges and universities are to develop courses on standardization, a collaborative effort is essential to make required resources available and affordable for students. Since companies depend on colleges and universities to supply employees, standards professionals and educators should not only challenge businesses for more funding support for such courses, but they should also challenge educational institutions to properly support such courses. After all, students of today are leaders of tomorrow.

**Conclusions**

Behind every product, service, and business there is a series of standards, without which, communication, interchangeability, and world trade would not be possible. There is an obvious gap between the important role that standards play in the world and the amount of education that individuals receive regarding such standards. While standards professionals recognize needs for multidisciplinary standards education coursework, there are many obstacles to overcome; specifically ways to fund such courses. However, despite the fact that company managers seem to agree on the vital role of standards within their organizations, many are hesitant to work with
educational institutions, let alone help fund such a course. Without continuing education about standards, the world will not operate as we know it today.

Bibliography:


Biographical information:

BRUCE A. HARDING an ASEE Fellow, is a professor of Mechanical Engineering Technology and Coordinator of Professional Practice. His current scholarship and engagement activities revolve around the development and application of American National and ISO standards dealing with Technical Product Documentation (TPD) as it broadly relates to manufacturing design and other technical aspects of Product Lifecycle Management (PLM). In turn, this expertise is woven back into his classroom instruction and research in standardization practices and process. He is member of the ANSI board of directors, ASME Vice President-Elect for Standardization & Testing and chairs the 62-country ISO committee for worldwide technical product documentation standards for PLM.

PAUL MCPHERSON a graduate instructor, received his Bachelors of Science degree Cum Laude in Technology and Industrial Arts Management with a minor in Business management from Berea College in Kentucky. He was a member of multiple honor societies including Epsilon Pi Tau, the Fleur De Lis honor society, and the Vincit Qui Patitur honor society and ASEE. At Berea he received the Peterson Spring Company award and served as the Berea College Technology Club President. For three years he worked as as an undergraduate teaching assistant, specializing in CAD, design principles and supervision of a student machine shop. He has had experience in metalworking, woodworking, and CAD/CAM design using a variety of the CAD and CAM programs. Using these tools he has designed and prototyped gear systems, reversed engineered and prototyped engine heads to be operated using 100% ethanol, and designed a faceplate for wood lathes. He was also a member of a team that designed and manufactured a product to be sold nationwide by a Berea student organization. At the graduate level he is interested in alternate energy, green manufacturing and the design constraints associated with these emerging technologies.

Appendix A

Survey Questionnaire

Do you hold a management position within this corporation, such as plant manager, division supervisor, floor manager, or line supervisor that will enable you to provide accurate answers to a survey about standardization within the company?
1. Please select the sector which best describes the company?

Medical  Automotive  Military/Government
Aviation  Construction  Health/Public Safety
Computer/Electronics  Alternative Energy  Other

2. How important is standardization (both company standards and national/international standards) in the overall growth and success of the company, the processes, the products, etc.?

Extremely Important  Neither Important nor Very Unimportant
Very Important  Unimportant  Not at all Important

3. Does the company offer any courses or opportunities for employees to increase their knowledge about the standards/standardization process?

4. How often are such courses offered?

Daily  Once a Week  Once a Month
2-3 Times a Week  2-3 Times a Month  Several Times a Year
Once a Year or Less  Never

5. Do employees attend training sessions offered by external organizations?

6. Is there a need for engineers who possess the fundamentals of standards development and the knowledge to find and apply standards prior to employment?

7. Approximately how many employees work for this company?

8. Who (job title) is responsible for development and compliance with technology standards?

9. Are any employees currently active participants within standards development organizations or active participants on standards committees?

10. Approximately how many employees do so?

11. How often are employees required to research, locate, and apply standards?

Very Often  Sometimes  Never
Quite Often  Rarely

12. Are the standards (national or international) required to complete company projects readily available to the employees working on the project?
13. Do current employees meet company expectations when determining what type of standard to use, how to locate the standard, and how to utilize the standard?

14. What types of standards are focused on?

15. Are all employees required to attend these courses?

16. In your opinion would taking a standards education course within colleges, universities, or high schools that focuses on both the development and the application of standards better prepare graduates to work for this company?

17. If such a course was offered and required for students would this potentially reduce the amount of on-site employee training?

18. Would this company be willing to work with local educational institutions to establish a curriculum in which more focus is placed on implementing education about standardization?

19. What types of standards would this company like to see applied within the curriculum to better prepare students for a career with this company or similar companies?

20. What type and approximately how much funding would be available to assist?

21. If a multinational competition were held for students to demonstrate their knowledge about standardization, would this company be willing to help sponsor the competitors?

22. What kind of support would this company be willing to offer?

Facility (web conferences)
Donations (monetary for prizes/scholarships)
Product (awards/prizes)
Internship Positions (winner)
Other