Impact of Accreditation on Internationalization of Engineering and Technology Education in the United States

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ABSTRACT: *The history of engineering education in the United States has a significant number of international roots and connections due to the immigration of large numbers of engineers, scientists and technologists from many different countries during the past two centuries. These talented entrepreneurs contributed to the development of emerging technologies, established and ran companies, started training and educational institutions, and influenced the shape of technological revolution for the 20th and 21st centuries. Even in 2003, this trend continues despite the recent political developments in America and other countries. Almost 49 percent of engineering students studying at the master's level in the United States is foreign born and two thirds of doctorate degrees in engineering go to international candidates who later become engineering or technology faculty members in the U.S. higher education system.*

This historical background and the composition of international graduate students and/or faculty members; however, does not make engineering and technology education in the United States a truly international endeavor. At the undergraduate level, a great majority of the engineering students and almost all of the technology students are domestic even if a significant percentage of teaching faculty and teaching assistants in engineering programs are international. With the exception of a few successful international engineering education programs, students are neither exposed to a sufficient amount of international components in the curricula nor do they experience anything international beyond the occasional accent of their professors in most of the U.S. engineering schools. After graduation; however, they end up working in multinational settings requiring interaction with international peers and occasional work outside the United States.

The first part of this paper traces some of the international roots of engineering and technology education in the United States and gives some examples of successful international engineering and technology programs, specially designed to accommodate student, faculty and curricula exchange among international partner institutions. The second part amplifies in detail the expectations by the new EC2000 and TC2001 accreditation criteria by Accreditation Board for Engineering and Technology, Inc. (ABET). The last section of the paper addresses how engineering and technology programs in the United States could use the new guidelines to positively impact the internationalization of their curricula and provide meaningful international experience for their students, faculty, administrators and staff members.

1 INTRODUCTION

England was the home of the industrial revolution of the mid eighteenth century with France and Germany following closely [1]. The first professional engineering school was established in France in 1747 (Ecole Nationale des Ponts et Chaussees) and the Ecole Polytechnique followed in 1794. Germany started the number of polytechnics in 1825, the first at Karlsruhe to train engineers. By that time, Britain already had number of engineers practicing in industry but the first engineering schools in London and Glasgow were not established until 1840. The British engineers later went to other countries to start engineering schools, such as the one established in Japan in 1873 and in USA.

The US Military Academy at West Point, established in 1802, was the first American engineering school with Claude Crozet, graduate of Ecole Polytechnique in France, the first engineering professor. Thus began the immigration of international engineers to US and as a result, the early engineering and technology education in the United States has international roots as a result of immigration patterns from Europe, Africa, and Asia to United States.

During the nineteenth century, the engineering profession that emerged in America was a blend of French that advocated academically based "school" and British which advocated practice-oriented "shop". Several French engineers served in American revolutionary war and some actually immigrated to America during the French revolution. These pioneer engineers, such as Sir Marc Isambard Brunel (1769-1849), Robert Fulton (1765-1815), Eli Whitney (1765-1825), and others trained and educated many American engineers before the turn of the century.

The internal combustion engine of Jean Lenoir (1822-1900) was a catalyst to start the auto industry in but US changed and revolutionized the industry through Henry Ford's work on automation and assembly line concepts. Half a century later, a group of German scientists and engineers helped US start the space program.

It is estimated that over 50 million immigrants from Europe went to USA during 1880-1920, giving rise to large and lasting impact of European engineering and technology education culture.

2 INTERNATIONAL ENGINEERING AND TECHNOLOGY PROGRAMS

The international flavor of engineering and technology programs in the United States are primarily due to two factors.

- More than one third of the engineering faculty in US engineering schools is foreign born. These faculty members bring some form of international perspective to the classroom from their background.
- About 9.7% of undergraduate engineering students in US engineering schools are international students. At master's level, this figure is close to 49% and it reaches to 67% for doctorate programs. Thus, international students make up almost ten percent of an undergraduate engineering class and their numbers dominate in the graduate engineering classes.

The percentage of international students and faculty in engineering technology programs is relatively low as compared to the percentages in engineering programs.

One of the most successful international engineering programs in US is at the University of Rhode Island [2]. About 175 engineering students are currently enrolled pursuing dual degrees of engineering and either German or French, or Spanish. The International Engineering Program (IEP) has internship and one semester of study abroad components.

University of Cincinnati [3] has a program offering opportunities for engineering, business, design, architecture, and planning students to learn a second language and gain international experience through an overseas co-op assignment.

University of Wisconsin, Madison [4] has semester abroad programs in many countries specifically designed for engineering students.

The national Science Foundation has the Office of International Science and Engineering [5] that promotes and coordinates international cooperation by supporting new partnerships between U.S. scientists and engineers and their foreign colleagues, or new cooperative projects between collaborators.

University of Maryland [6] offers Citation in International Engineering if a student completes study abroad, research abroad, or internship abroad. The citation is recorded on the student transcript.

Texas A&M University [7] international engineering education center offers several study abroad programs for engineering students.

Pennsylvania State University [8] and several other universities offer variety of study abroad programs.

Indiana University Purdue University Indianapolis (IUPUI) started dual degree program in engineering and German [9]. There are plans to add another dual degree program in Spanish and engineering.

3 ABET ACCREDITATION CRITERIA

Criterion 3 of the ABET EC 2000 guidelines expect for engineering programs to demonstrate that their graduates have the skills a-k listed in ABET documents [10]. The two items, (h) and (j) are of interest in this paper.

(h) the broad education necessary to understand the impact of engineering solutions in a global and societal context and

(j) a knowledge of contemporary issues are specifically applicable to internationalization of engineering curricula.

There is an expectation by ABET, however, that "engineering programs must have a curriculum or other program requirements in place that provide students opportunities to learn, practice, and demonstrate elements listed in (h) and (j)" [10]. Secondly, "program must have an appropriate assessment process in place that produces documented results that demonstrate that students have achieved each and every item listed in (h) and (j)" [10]. Thirdly, "the assessment process should include direct and indirect measures and does not rely only on self-report surveys and evidence that the material is covered in the curriculum." [10]

For engineering technology programs, Criterion 2 of the ABET TC 2000 guidelines expect these programs to demonstrate that graduates have skills a-k listed in ABET documents [11]. Specifically the skill spelled out by item (j) described below corresponds to items (h) and (j) of engineering.

(j) a respect for diversity and a knowledge of contemporary professional, societal and global issues.

It is interesting to note that European nations addressed the issue of internationalization of engineering and technology education long before any serious efforts were launched in US. Exchange of students and faculty members among several European countries were facilitated through the important milestones such as FEANI accreditation in 1971, European Union program ERASMUS in 1987, and the BOLOGNA declaration in 1999.

4 LEVERAGING OF ACCREDITATION FOR INTERNATIONALIZATION

University of Illinois, Chicago organized an NSF sponsored forum in May 2001 on issues in international engineering education. Participants included engineering faculty from higher education institutions in Canada, European Union, Mexico and the US, global industry leaders and managers, and US federal government representatives. The forum was asked to answer the broad questions of what "international engineering" is and what should academic institutions do to address it [12].

The forum participants felt that internationalization should not be limited to requiring engineering students learn a foreign language or two but should be broad to include acquiring skills in project management, intellectual property law, business, and research training as engineering students participate in diverse and international teams. One interesting collaborative international effort is a joint design done by team of engineering students from several universities around the globe where they need to understand the engineering design standards in all the participating countries [13].

ABET accreditation guidelines may serve as a useful framework to build an effective international engineering and engineering technology programs. Some of the following strategies have been tried with success.

- Design a five-year dual degree program to offer BS in engineering and engineering technology program and BA in a one of the foreign languages. The highly successful University of Rhode Island program offers the options of German, French, and Spanish.
- Create summer internship opportunities abroad.
- Articulate study abroad program with colleges and universities abroad so that students may spend a semester abroad, enrol in engineering or engineering technology courses in that institution and transfer the credits back to the home institution.
- Also articulate the interchange ability of courses with universities abroad so that some international students spend a semester in a US institution with an option of completing the degree in US.
- Collaborate with the academic programs in liberal arts, business, and others to design specific courses for engineering and engineering technology students to address the contemporary, societal, and global issues as required by ABET.

5 CONCLUSIONS

Graduates of engineering and engineering technology programs face constantly evolving challenges some of which are not technological in nature. During their careers which may span thirty years or more, they will work in teams where the nuances of communication and understanding of different cultures will be essential to avoid confusion resulting from variations of local idioms.

Preparation of engineering and engineering technology workforce for this new global setting requires deliberate and careful planning on the part of engineering and engineering technology schools, as counting on accidental mixture of domestic and international students and faculty will not provide the truly international program. Several engineering schools in the US, such as the University of Rhode Island, have initiated effective and attractive international engineering programs.

The new ABET accreditation guidelines, EC 2000 for engineering programs and TC 2000 for engineering technology programs; require that students are exposed to the issues of globalization and societal context of engineering. It is possible, therefore, to put a sound internationalization process in place and meet the ABET requirements.

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