The Engineering/Engineering Technology Divide in the United States

Faculty Paper

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Abstract

The industrial revolution that took place in the second half of the nineteenth century in the United States fostered the need for a technically competent work force that was capable of serving the needs of an economy that in turn was developing new technologies at a rate unsurpassed in the history of humankind. At the engineering design level, the founding of the American Society for Engineering Education (ASEE) and the Engineering Council for Professional Development (ECPD) as an accrediting agency in the mid 1930’s were reflective of the efforts of higher education to respond to this need for quality assurance in the educational preparation of engineers. In 1980, ECPD metamorphosed into the Accreditation Board for Engineering and Technology (ABET).

At the technician level, the response was less organized and more diffuse, with the emergence of many post-secondary trade schools in the first half of the twentieth century. Such schools were highly focused upon the requirements of a specific industry, and were almost always private, for-profit entities outside the realm of the public education system. Rarely were they concerned with prior educational achievements; that is, they frequently did not demand a high school diploma or its equivalent for admittance. Nevertheless, within the realm of the subjects taught, these trade schools promoted rigorous standards, recognizing that their own sustainability was contingent upon producing graduates who possessed the technical competence that industry required.

Introduction

In the second half of the nineteenth century, major changes were evolving in the engineering enterprise in the United States. Specifically, the development of more complex mathematical algorithms, the chemical synthesis of new materials, and the invention of the now ubiquitous computer made possible engineering designs that had previously not been possible. Such designs were of a level of sophistication that they mandated the presence in industry of individuals who, on the one hand, possessed sufficient mathematical knowledge to be able to comprehend fully the complexities of the design, yet conversely, the hands-on technical expertise to oversee its implementation by
the craftsman. Thus was born what is now in the United States as the engineering technologist.

The education of engineering technology students largely evolved from the aforementioned post-secondary trade schools, but such programs are now almost exclusively located in colleges and universities. This in turn is due to the nature of the disciplines as they have evolved, which almost universally require mathematics at the level of the calculus, as well as college level physics and chemistry, and are therefore worthy of a college degree. Nevertheless, the issues of what constitutes the differences between engineering and engineering technology consume faculty at colleges and universities across the United States, and have done so for the better part of the past half-century. This paper will explore the parameters of this debate as it has been constituted, and a case study of how one institution that awards degrees in both engineering and engineering technology has responded.

Background

The founding of the American Society for Engineering Education (ASEE) in 1893 in Champagne, Illinois (now the site of the University of Illinois at Champagne-Urbana) represented a milestone in education in the technological disciplines in the United States. Engineering, which by all accounts appears to have been the illegitimate stepchild of higher education in the nineteenth century, emerged in the twentieth century as one of the most prestigious and intellectually demanding courses of study in American colleges and universities. The founding of the Engineering Council for Professional Development (ECPD) as an accrediting agency in the mid-1930’s was a second major step in legitimizing what was already recognized as a major force in what is often called the “American Century” in that it assured a large supply of individuals who were technically competent and who could orchestrate America’s rapidly expanding industrial and manufacturing base, to accompany its already dominant agricultural miracle.

The increased acceptance of university degrees in engineering as a measure of design competence was accompanied by a much quieter revolution in the United States, specifically, the development of post-secondary “trade schools”, whose function was to prepare technicians who would implement the design of the now burgeoning quantity of engineers. Unlike the case of engineering education, there was little regulation and oversight of these institutions, and the professional societies and accreditation of such schools lacked the sophistication present in engineering education. What was widely accepted was a rigid demarcation line between “engineers’ and “technicians”; each had their own area of expertise, and each had their own set of job titles and salary schedules within industry.

This rigidly ordered class system witnessed the first blurring of boundaries as the result of three scientific advances in the first half of the twentieth century: new algorithms in mathematics, new materials developed by chemists, and the computer, the net effect of
which was to make possible designs which heretofore had not been possible. [Perhaps the most obvious example of this was the evolution of indoor stadiums whose design no longer had to include supporting pillars leading to seats with obstructed views.] The engineering enterprise in turn responded by evolving a new category of worker known most frequently as the engineering technologist, an individual who had a foot in either camp, i.e., sufficient mathematical and scientific sophistication to understand the design of the engineer and concurrently a “hands-on” capability to oversee the implementation by the craftsman.

Several events delineate the gradual emergence of engineering technology as an accepted academic discipline. The first of these was the recognition by the aforementioned ECPD of seven technical programs at three institutions at the associate degree level in 1946. This was followed by the first accredited program in engineering technology at the baccalaureate level at the University of Dayton in 1967. In 1980, ECPD metamorphosed into the Accreditation Board for Engineering and Technology (ABET) as it is known currently. The presence of the word “technology” in the name of the organization was especially significant, in that it gave a fundamental legitimacy to this area of study.

Current Status of the Engineering Education System in the United States

Force Commission (EWC) of the American Association of Engineering Societies (AAES), in the Fall of 2009, there were more than 435,000 full-time undergraduate students pursuing engineering education. They were joined by the more than 114,000 full-time graduate students and more than 78,000 part-time students in both undergraduate and graduate levels. In total, there were more than 628,000 students pursuing engineering education in the United States one year ago.

With respect to the individual engineering disciplines, AAES recognizes some twenty-four separate and distinct disciplines, the largest of which is mechanical engineering with more than 117,000 students enrolled. [That status is somewhat deceiving given that some institutions combine electrical and computer engineering into one category and others separate them; if one looks at the combined electrical and computer engineering, its combined total is than 184,000 students.] Engineering is offered at some 361 institutions of higher education, of which 337 have at least one ABET-accredited program.

The enrollments in engineering technology are much smaller than those in engineering, and also occur at different levels. More than 36,000 full-time students were matriculated into associate degree programs in engineering technology in 2009 in the United States and more than 35,000 into baccalaureate programs. They were joined by more than 38,000 part-time students, giving a total of more than 109,000 students in engineering technology. The near total absence of graduate programs in engineering technology is a reaction to market forces in which industry has, for the most part, as yet to define a need for individuals with a graduate degree in engineering technology. The largest single major is electronic engineering technology, with more than 14,000 (electrical engineering
technology is separated from electronics, as is computer technology). These programs
are offered by 276 academic institutions, the vast majority of which have at least one
ABET-accredited program.

An additional factor to be considered is professional registration as an engineer. In the
United States, this is under the control of state governments rather than being a national
standard. In thirty-five of the fifty states, a graduate of an ABET-accredited
baccalaureate program in engineering technology may sit for the professional engineer’s
exam.

A 2003 survey of colleges and universities in the United States revealed that of the
hundreds of institutions that offer either engineering or engineering technology, only
fifty-five offer both engineering and engineering technology. Designing curricula that
are appropriate for each as well as administrative structures, hiring practices, and
promotion and tenure criteria are a challenge for deans, department chairs, and faculty.
What follows is a case study as to how one institution responded to this issue.

case study: engineering and engineering technology at the university of hartford

The University of Hartford is a private, non-sectarian, comprehensive, mid-size
university. Founded in 1957 by the merger of three local institutions, the University
enrolls some 7000 students, of whom more than 4700 are full-time undergraduates, and
of whom more than 3500 reside on campus. The University is currently organized into
seven colleges, one of which is the College of Engineering, Technology, and
Architecture, known on campus by the acronym CETA. More than ninety undergraduate
majors and thirty graduate programs are offered university-wide, including four at the
doctoral level. CETA in turn offers associate and baccalaureate degrees in engineering
technology, and baccalaureate and master’s degrees in engineering. An enrollment of
nearly one thousand students in CETA is served by some forty full-time faculty and an
approximately equal number of part-time, adjunct faculty.

Throughout its history, collegiate structure at the University of Hartford has not been
constant, with at least one major alteration in each decade of the University’s existence.

In the first decade of the twenty-first century, there were two such alterations, one of
which was the merger of the College of Engineering with the College of Technology to
form the entity named above.

The evolution of this unified college resulted from very different histories. The college
of technology had been founded as a proprietary school of electronics in 1948 (the same
year that Shockley, Bardeen, and Brattain of Bell Labs published their seminal paper on
the transistor effect, for which they won the Nobel Prize in 1956). The proprietary school
was subsequently given to one of the entities that merged to form the University of
Hartford in 1957. Ultimately, the school acquired degree granting authority, first at the
associate level (1964), then at the baccalaureate level (1978), and, in the decade of the
nineties diversified into disciplines beyond electronics. [One of these, architectural
ing engineering technology, now boasts the second largest enrollment among the ninety
undergraduate majors in the entire University.] There are currently four programs in
engineering technology that enjoy ABET-accreditation, three at the baccalaureate level
and one at the associate level.

Conversely, the college of engineering dates its history back to the nineteenth century,
when it was taught as a part of the local commuter college that in turn was part of the
1957 merger. There are currently six ABET-accredited programs in engineering the first
two of which received initial recognition in 1967, the last of which was certified in 2010.
The college of engineering and the college of technology were separate entities, each
with their own dean, and each with their own faculty through most of the history of the
University.

In the late nineties, conversations began regarding the desirability of merging the colleges
of engineering and technology. Several factors were paramount. The first of these was
(as always) financial. The two colleges were among the smallest in terms of enrollment
and faculty in the University, and merging them offered an opportunity to reduce
administrative costs. Secondly, the laboratory facilities in many cases represented
duplicates that were underutilized. It did not help that the two schools were situated at
opposite ends of the campus.

Nevertheless, the prime motivation was to develop a college that would be “…locally
prominent and nationally recognized…” in the pedagogy of the technological disciplines,
an achievement that was not possible when the faculty and resources in those disciplines
were divided.

Several factors mitigated such a merger. The first of these was the dramatic growth of
the University’s enrollment in engineering technology during the decade of the nineties
(in contrast to the dramatic decline in enrollment in engineering technology that occurred
nation-wide during the same time period). Indeed, since the year 2000, the full-time
undergraduate enrollment in engineering technology at the university has been roughly
equal to those at the undergraduate level in engineering, a phenomenon that is rare across
the United States, where there the ratio of full-time undergraduate engineering students to
full-time undergraduate engineering technology students is about 6:1.

The second factor was the credentials of the faculty. During the decade of the nineties, as
older faculty in technology retired, they were replaced largely with faculty with Ph.D.’s
in engineering, to the point whereby the credentials of the two faculties were nearly
indistinguishable. Moreover, faculty in technology enjoyed identical success in attaining
tenure and promotion. This removed what had historically been a major obstacle to
cooperative efforts between the two schools.

A third and perhaps the deciding factor was the desire to make readily available to all
students in the technological disciplines the expertise of all faculty who had degrees in
Proceedings of the 2011 ASEE Northeast Section Annual Conference
University of Hartford
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their respective disciplines. Thus, for example, the faculty member in engineering with expertise in digital signal processing would work side by side with the faculty member in technology with the same specialty, and the students would have easy access to both faculty, regardless of whether they were students of engineering or technology.

To accomplish this, a merger was arranged that had three dimensions. The first was an administrative merger that took place on 1 July 2003. This meant that there is one dean, one promotion and tenure committee, one academic standings committee, one curriculum committee for the entire college. Departments were organized by discipline rather than by engineering versus technology, with oversight of numerous programs. For example, the department of electrical and computer engineering oversaw six programs: electrical engineering, computer engineering, electronic engineering technology, computer engineering technology, and audio engineering technology, all at the undergraduate level, and electrical engineering at the graduate level.

The second dimension was a physical merger that occurred in January 2006. A major construction of a new building and rehabilitation of existing buildings allowed the consolidation and modernization of existing laboratories, and the faculty of the two schools to be in the same location (with the exception of architecture, whose studio needs were beyond the physical limits of this reconstruction).

The third dimension was, for purposes of this discussion, arguably the most significant and controversial. Existing faculty were allowed to continue teaching either solely engineering or solely technology, but future hires were to be made with the understanding that they would be expected to teach both engineering and engineering technology. It was felt that this was the most optimal mechanism whereby the goals and objectives of the merger could be achieved without incurring trauma among the faculty. This process has been especially effective in the college, with the department of electrical and computer engineering being particularly successful.

Conclusion

Among the approximately fifty-five institutions that offer both engineering and engineering technology across the United States, there are numerous administrative structures. The degree of integration espoused by the University of Hartford is rare (though not unique), but it has succeeded dramatically in elevating the technological disciplines at the University of Hartford to a status heretofore not enjoyed. The ensuing decade will be a true test if this merger and integrative structure is to become a new paradigm in a divided engineering community.
References


