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Identity Issues and the Future of Civil Engineering Technology

Abstract

This paper discusses issues associated with the academic definition of engineering technology and the professional identity of the engineering technology graduate. A review of literature indicates that the terms engineer and technician have been around relatively longer than the term engineering technologist. In addition, there is ample evidence that the terms engineer and technician are more precisely defined and that they are more easily understood than the term engineering technologist.

Many groups that have vested interest in the identity issues and the definition of engineering technology have been identified. The main groups discussed in this paper include:

- prospective engineering and engineering technology students,
- academic institutions that are recruiting students into engineering or engineering technology programs,
- engineering technology students,
- engineering technology academic departments developing curricula for their programs,
- engineering technology graduates,
- employers of engineering and/or engineering technology graduates,
- professional engineering societies,
- engineering and engineering technology accrediting agencies, and
- technical licensing agencies.

On the basis of existing literature and the author's interaction with the various groups of stake holders, it has been observed and concluded that there are indeed issues with respect to the functional identity of engineering technology graduates.

- It has been noted that engineering technology graduates are currently eligible to apply for professional licensure in more than half of the states in the U.S. In a smaller fraction of states, engineering technology graduates are not eligible to apply for licensure as professional engineers.
- A few employers use interchangeably the terms engineering technician and engineering technologist.
- At many work places, engineering and engineering technology graduates are both referred to as engineers when professional licensure is not implied.
- Within the civil engineering practice, sometimes it is not easy to distinguish among the professional mandates of a civil engineering technologist, a practicing construction engineer, a practicing construction management graduate, and other civil engineering specialists working closest to the product.

The author believes that this paper brings up timely issues regarding the engineering technologist and about the future of Engineering Technology. New requirements for licensure of the future engineer seem to suggest that it will be more difficulty for the engineering technology graduate to obtain permission to apply for licensure as professional engineer.

Introduction

A review of literature indicates that the terms engineer and technician have been around relatively longer than the term engineering technologist. In addition, there is ample evidence that the terms engineer and technician are more precisely defined and that they are more easily understood than the term engineering technologist. Further, it has been observed that one of the major routes of advancement for engineering technology graduates is through passing the fundamentals of engineering (FE) exam. This expectation from the work place has paramount influence on the aspirations of engineering technology students and graduates. It also has significant influence on how engineering technology programs define their objectives.

Although the objective of this paper is to bring up identity issues with respect to the engineering technologist in general, the discussion is based mostly on the author's experience and observation within the civil engineering discipline.

Descriptions and Definitions

The Bureau of Labor Statics (BLS) of the US Department of Labor classifies technical professional associated with engineering in two major categories in terms of professional achievements as engineers and engineering technicians[1]. The BLS descriptions are given below:

> Engineers*:* "Engineers apply the principles of science and mathematics to develop economical solutions to technical problems. Their work is to link between scientific discoveries and the commercial application that meet societal needs"
>
> Engineering Technician: "Engineering technicians use the principles and theories of science, engineering, and mathematics to solve technical problems .... Their work is more narrowly focused and application-oriented than that of scientist and engineers". Many engineering technicians assist engineers and scientists, especially in research and development. Others work in quality control and manufacturing.

In addition, on the basis of the generic definitions of the engineer and engineering technicians, the BLS provides corresponding descriptions of the civil engineer and civil engineering technician. It should be noted that the BLS states that technicians assist engineers. However, The BLS does not provide a separate category for engineering technologists. What does the absence of the engineering technologist category mean? To answer this question, the author reviewed the BLS literature about the education and training required for engineers and engineering technicians. The BLS summary descriptions for the respective training requirements are provided below.

Education and training for engineering technicians: The description of education and training for engineering technicians is quite specific. It states that most engineering technicians enter the occupations with an associate degree in engineering technology obtainable from technical institutes, community colleges, vocational-technical schools, and extension divisions of colleges and universities.

Education and training for engineers: The BLS states that the basic education and training for engineers is a bachelors degree in engineering. In addition, the BLS reported that many colleges offer 2-year and 4-year degree programs in engineering technology. The BLS provides the following notes regarding 4-year engineering technology programs:

- The programs include various hands-on laboratory classes that focus on current application issues.
- Students are prepared for practical design and production work, rather than jobs that require more theoretical knowledge.
- Engineering technology graduates may obtain jobs similar to those given to engineering graduates.
- Engineering technology graduates are not qualified to register as professional engineers under the same terms as graduates with degrees in engineering.
- Some employers regard 4-year technology program graduates as having skills between those of a technician and an engineer.

It is interesting that the BLS places 4-year technology program graduates in a spectrum between engineers and technicians but rarely uses the term technologist. It is also notable that although the term "technologist" is commonly used in academic discussions, it is seldom used by employers. The question then is why not? Further, is the lack of popularity of the term among employers important? The author does not know the why part of the question but believes that this observation is important. The limited use of the term technologist in the work place has significant implications to the professional identity of the 4-year technology program graduate.

Identity Issues of the Civil Engineering Technologist

Several groups have vested interest in the professional identity of the engineering technologist. They include:

- prospective engineering and engineering technology students
- academic institutions recruiting students into engineering or engineering technology programs,
- engineering technology students,
- engineering technology academic departments developing curricula for their programs,
- engineering technology graduates,
- employers of engineering and/or engineering technology graduates,
- professional engineering societies,
- engineering and engineering technology accrediting agencies, and
- Technical licensing agencies.

Regardless of the type of group, most of the identity issues revolve around recognition, compensation, and business considerations. The major issues for each group are discussed in the following sections.

Prospective College Students

For the purpose of this discussion, prospective students are individuals who plan to enroll in engineering technology degree programs. Generally, this group asks questions regarding graduation requirements, employment prospects, recognition and rewards.

One of the key questions that prospective engineering technology students ask is whether they will be allowed to take the *Fundamentals of Engineering (FE)* exam. These individuals know that passing the FE exam will result in (a) recognition when they obtain the title of *engineer-in-training* (EIT) or engineer intern (EI), (b) monetary rewards since many employers recognize the added value of the EI, and (c) opportunities to take the *Principles and Practice of Engineering* (PE) examination. However, prospective students seldom ask how the graduation requirements match the competence elements required to pass the FE and PE examinations. The author believes that prospective students need to know the implication of enrolling in a technology degree program if their primary objective is to obtain professional engineering registration.

College Students in Four-Year Degree Programs

Some engineering technology students consider opportunities for graduate studies. A significant factor in their consideration is the type of available opportunities in graduate studies. Generally, opportunities for graduate studies for engineering students are available as specialties within engineering. Typically, civil engineering graduates find graduate programs in the traditional civil engineering subspecialties such as construction engineering, environmental engineering, geotechnical engineering, hydraulics and hydrology, structural engineering, and transportation engineering. However, such opportunities are not readily available to civil engineering technology graduates. In addition, work completed for the technology degree is not normally accepted by graduate engineering programs. Therefore, there is no parallel academic advancement system for the engineering technology student.

The identity issue in this case is that while engineering technology students are allowed or encouraged to pursue certifications to become engineering interns and, in some cases, to obtain professional licensure, there is no clear path for the academic development needed to facilitate their professional advancement.

Recruiting Departments of Academic Institutions

Recruiting departments of academic institutions try to provide clear statements about the professional prospects of the students they recruit. However, because both engineering and engineering technology programs contain the term engineering, recruiting departments in universities do not seem to define adequately the critical elements that distinguish engineering and engineering technology programs. While there may be many reasons for the lack of clarity, one of the most common reasons is lack of understanding of the distinction between the two types of programs by the personnel in the recruiting departments.

Academic Departments

Recruiting and Academic Concerns: Engineering technology departments are faced with two major issues when they participate in recruiting. The first major item is associated with the business considerations of recruiting. Business considerations are concerned with enrollment numbers. The second issue is derived from consideration of integrity of the academic departments that define parameters for program quality.

Business Considerations: Since business considerations call for enrollment numbers, it is not surprising that departments will try to recruit as many students as possible. Therefore, the recruitment literature is prepared not only as program information dossier but as program advertisement. A program information dossier typically includes (i) a brief description of the degree program, (ii) a 4-year curriculum, (iii) a sample of job functions and entry positions, (iv) a sample of positions held by successful alumni, and (v) statistics of graduate job placements. In general, the emphasis is in the elements that are considered as most attractive to the prospective students. Most departments provide excellent dossiers to promote their programs. However, promotional dossiers do not always provide adequate or accurate information regarding the critical distinctions between engineering and engineering technology programs.

Academic Issues: The parameters for promoting academic integrity and the marketability of program graduates include elements that describe (a) requirements of and rigor in the math and science content, and (b) statistics of passing rates for nationally-normed exams. This area is a bit problematic for engineering technology programs for two main reasons. First, departments have to market technology programs as programs with emphasis on hands-on experience, having limited work on theoretical analysis, and with curtailed math requirements. Second, these departments wish to prepare graduates who can compete in the market place. Usually, engineering technology graduates compete with engineering graduates for jobs that fall in areas that require similar competencies, especially in the design and production management areas. The boundary between the need for accuracy in describing engineering technology curricular requirements and the ambition to provide a competitive edge to graduates is frequently so blurred that it constitutes an identity problem.

Faculty professional identity: An additional identity concern in engineering technology is derived from the composition of program faculty. It can be observed that a significant proportion of faculty members in engineering technology programs are engineering graduates. As such, regardless of the documented definitions and expectations of technology programs, the faculty identity with engineering does, in a subtle way, cause an identity concern with their students. Engineering Technology programs are unique in this respect in that the teaching-and-learning endeavor involves interaction between trainees of a slightly different academic category from that of their trainers. In most other professional programs, instructors are involved in the training of their own kind, even though they may be of a slightly different specialty. Generally, nurses train nurses, engineers train engineers, soldiers train soldiers, doctors train doctors, etc.

Engineering Technology Graduates

As implied by program names of engineering technology programs and degrees, an engineering technology degree is, technically, not an engineering degree. It is a technology degree. The adjective "engineering" describes it as an engineering-related degree or technology degree dealing with engineering issues. The depth and breadth to which an engineering technology program deals with engineering depends on the defined program objectives and curriculum. Since engineering technology curricula vary greatly, it is difficulty to predict accurately graduate competences from similarly named technology programs. Certainly, there is a wide spectrum of graduate competences.

While technology graduates wish to be readily recognized and given standard titles at their places of employment, the wide range of competences expected for engineering technology graduates is an impediment to having blanket recognition and is often a source of identity concern.

What Students Learn in Civil Engineering Technology Programs

The author has had to answer the question about what is taught in a four-year civil engineering technology program. The author typically addressed that question with the following statement:

> *"On similar topics, engineering technology students are taught the same engineering concepts as those taught to engineering students. Engineering technology programs teach engineering; not engineering technology. On the one hand, there is a significant overlap between engineering and engineering technology curricula. On the other hand, there is an appreciable offset in the coverage of the engineering spectrum. Therefore, due to the difference in breadth for some topics and depth in others, engineering technology curricula lead to the degree in engineering technology …"*

The statement given above is based on the author's experience from teaching in engineering technology programs, and as a student of and graduate from engineering programs; and on the author's familiarity with existing engineering and engineering technology programs in the U.S. and other countries including Germany and the UK.

Employers

The wide range of technology graduate competencies precipitate identity concerns as exemplified in the following cases.

- Upon employment, technology graduates would like to receive immediate recognition in their areas of competence. However, employers may not be willing to give the recognition till graduates demonstrate those competences. The same recognition is generally automatically extended to engineering graduates because of their identity and engineering graduates.
- Occasionally, employers hire technology graduates and engineering graduates to perform similar tasks. At the same time, these employers offer different entry level compensation. This scenario occurs frequently in government agencies where the differential

compensation packages offered to new graduates are due to statutory requirements and are not based on specific competences of the graduates.

Some employers use interchangeably the terms engineering technician and engineering technologist. However, at many work places, engineering and engineering technology graduates are given similar job titles when professional licensure is not implied. A few examples of the titles are: Associate Engineer, Engineering Specialist, Engineer-In-Training, Engineering Associate, Engineering Intern, City Engineer, Civil Engineer, Project engineer, etc.

Within the civil engineering practice, sometimes it is not easy to distinguish among the professional mandates of a civil engineering technologist, a practicing construction engineer, a practicing construction management graduate, and other civil engineering specialists working closest to the product. Examples of production activities include (1) preparation of construction drawings, (2) preparation of a hydrology report for a project site, (3) installation of a subsystem for construction project, (4) preparation of project feasibility report, (5) preparation of a project cost estimate, and (6) schedule preparation of a construction project.

It should be noted that civil design and construction companies are production companies that are engaged in highly regulated and reasonably standardized work. Therefore, both civil engineering and civil engineering technology graduates are likely to work on similar assignments and receive the same level of compensation. The identity issue in this case is generally derived from the fact that individuals of different academic backgrounds, perhaps with different competences, lose their identity due to their placement in similar functions.

Professional Societies and Accrediting Organizations

There is ample evidence from literature[2, 3] that professional societies and organizations that accredit academic programs maintain distinct definitions and descriptions for the three professional categories – technician, technologist and engineer. Therefore, there is seemingly no serious identity problem among these categories within the confines of these organizations. However, the main challenge to the professional societies and accrediting organizations is to make sure they are not the only bodies that embrace those definitions and descriptions.

Licensing Agencies

At present, engineering technology graduates are eligible to apply for professional licensure in about 30 to 35 states in the U.S.A. A sample of states that allow ET graduates to apply for professional licensure is provided in Table 1. Of the remaining 15 to 20 states, the rules regarding ET graduates vary and include: (a) case-by-case review of undergraduate degree transcripts of graduates, (b) requiring a masters degree from an engineering school that has an ABET-accredited undergraduate degree program in the same discipline, and (c) complete restriction of ET graduates from licensure.

To most engineering technology graduates, ineligibility is a concern because it is based only on identity. There are reported cases where academic programs have configured their technology curriculum to provide their graduate with competences that enable them to pass the FE

examinations. However, existing statues do not allow those graduates to take the FE examination in some states, including the home states of the programs.

The lack of uniformity in the licensure laws among states is a subject of discussion. This is particularly important because some of the technology graduates pass the FE exam when allowed to take. In addition, a few of those who pass the FE have later successfully licensed themselves as professional engineers.

The discussion about licensure and arguments for or against allowing ET graduates to seek licensure has seemingly revolved around two opposing principles. The first argument is based on the principle that individuals who want to become licensed engineers should enroll into engineering programs. The implication of this view is that engineers are "*created*" in engineering programs and that the FE and PE exams are in place to serve only as quality control procedures. The opposing argument is based on the assumption that the objectives of the FE and PE exams is to test competence of the examinees. Accordingly, the proponents of this argument support the process whereby both engineering and engineering technology graduates are given an equal opportunity to demonstrate their competences.

Table 1: A Sample of States that Allow ET Graduates to Apply for Licensure

1	Alaska	11	Maryland	21	Oregon
2	Arizona	12	Montana	22	Pennsylvania
3	California	13	New Hampshire	23	Rhode Island
4	Colorado	14	Nevada	24	South Dakota
5	Connecticut	15	New Jersey	25	Texas
6	Delaware	16	New Mexico	26	Utah
7	Georgia	17	New York	27	Vermont
8	Idaho	18	North Carolina	28	Virginia
9	Massachusetts	19	North Dakota	29	Washington
10	Maine	20	Ohio	30	Wisconsin

At this time, it seems most states in the U.S. still subscribe to the latter view which allows ET graduates to apply for registration. Nonetheless, neither view seems to satisfy both categories of graduates. Engineering technology graduates are happy with the equal opportunity model. However, it is not clear whether engineering graduates prefer one model to the other. In any

case, since enrollment in an engineering program bears implications on the scope and depth of academic rigor in mathematics and the sciences, it would not be surprising to find that engineering graduates prefer a model that recognizes their added responsibility of dealing with the additional quantity and rigor in the math and sciences.

The Future Professional Engineer

The National Council of Examiners for Engineering and Surveying voted in 2006 to require additional education for engineering licensure[4]. One of the approved statements in the requirements stipulates that, "an engineer intern with a bachelor's degree must have an additional thirty (30) credits of acceptable upper-level undergraduate or graduate-level coursework from approved providers in order to be admitted to the Principles and Practice of Engineering (PE) examination. A careful review of literature seems to indicate that the future engineer will be an engineering graduate. At this time, there has been little or no discussion about the future of the engineering technologist. Certainly, one of the objectives of this paper is to break the silence and start a discussion about the future of engineering technology programs.

The Future of Civil Engineering Technology Programs

On the basis of the current discussions regarding the required body of knowledge of the future professional engineer[5], it seems that the engineering technology graduate will encounter significant problems in applying for professional licensure. The organizations involved in the development of standard requirements have not made any explicit statement on whether there will be a parallel or alternative path to enable the engineering technology graduate to qualify for licensure.

Due to the absence of discussion about the future of civil engineering technology programs, some schools have indicated the possibility of abandoning their four-year civil engineering technology curricula and replacing them with civil engineering programs. In the wake of the anticipated comprehensive changes in the engineering programs, it seems prudent to think simultaneously about engineering technology programs. Therefore, this is probably an opportune time to start a discussion about the future of the civil engineering technologist and civil engineering technology programs.

Summary

This discussion has been mainly about the technical definition of engineering technologists. It was noted that:

- Engineering technicians and engineering technologists receive their academic training from engineering technology programs.
- Generally, engineering technicians are graduates of two-year associate degree programs while engineering technologist are graduates of four-year degree programs.
- By definition, an engineering technologist is a category within the technical spectrum between the technician and the engineer.
- Graduates from engineering technology programs are often allowed or encouraged to take the fundamentals of engineering (FE) exams to gain certification as engineer interns

(EIs). Further, the EI certification makes them eligible to apply for licensure as professional engineers (PEs).

- When engineering technology graduates obtain PE licensure, they are recognized as engineers. Their identity and function become indistinguishable from engineering graduates.
- Most employers seldom use the title "engineering technologist" for their engineering technology graduates. They call them by such titles as technician, senior technician, engineering specialist, engineering associate, associate engineers, engineers, etc.
- *Engineering Technologist* is not a familiar term outside academia. Therefore, parents and prospective students do not understand clearly the prospects of engineering technology degree programs.
- Generally, postgraduate engineering programs do not accept undergraduate academic work of applicants from four-year engineering technology programs.
- The future engineer is expected to receive a broader academic body of knowledge. However, it is not yet known what path engineering technologists will follow to obtain the required breadth of the body of knowledge.

Recommendations

It is recommended that the civil engineering community and the engineering community at large address the question about the future of the engineering technologist. The discussion about the future of the engineering technologist ought to address issues about whether the engineering community has any interest at all in the type of practitioners who graduate from engineering technology programs.

An important component of such discussion should include a careful review of the history of engineering technology programs. It should be noted that engineering programs had been in existence for many years when engineering technology programs were developed. Therefore, the engineering community needs to address, among others, the following questions:

1. What precipitated the need for engineering technology programs?
2. Does the need for engineering programs still exist?
3. What will happen if schools abandon baccalaureate engineering technology programs?
4. What needs to be done to sustain engineering technology programs?
5. Are graduates of engineering technology programs capable of becoming professionals?

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