120th ASEE Annual Conference & Exposition
FRANKLY, WE DO GIVE A D*MN
June 23-26, 2013

Paper ID #8020

Assessing the Value of Bachelor Graduates in Engineering Technology (ET): Making the Case for a Proper Valuation of ET Skills in Industry

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Abstract

Ron Land's paper[1] "Engineering Technologists Are Engineers" (Land, 2012) and the Department of Labor both seem to agree that graduates with engineering technology (ET) degrees end up having careers is engineering. Professor Land comes upon his conclusion from surveying over 200 companies that hire both engineers and engineering technology graduates. The Department of Labor came to a similar conclusion when they turned down the petition for a separate code for engineering technologists. It is worthwhile to note that the Department used employment data of ET graduates to reach this decision.

This paper looks at the immediate value of an engineering technology bachelor degree graduate to her employer by studying ETAC and EAC program criteria. Comparisons will be done for two pairs of similar degrees by looking at their ABET program requirements. The first will be a comparison between the electrical and computer engineering (ECE) and the electronic and computer engineering technology (ECET) programs and the second between mechanical engineering (ME) and mechanical engineering technology (MET) programs. Relevant literature will be used to back up any assertions that are made. The paper provides a rationale of why ET graduates should be valued by industry for their differences as well as their similarities. It argues that new ETs bring important benefits to the workplace that justifies their proper valuation and compensation (similar to engineers) starting on day one.

Introduction

The evolving consensus that ET graduates end up as engineers is desirable from several perspectives which includes the creation of an additional pathway to increase the numbers of engineers. So yes, engineering technology leads to engineering careers, but, is there something more to such an academic pathway that brings about benefits prior to the career merger that eventually takes place? What benefits are reaped by companies which employ people from both tracks? Do these benefits transcend individual companies and produce positive impact at a national and/or global level[2,3]? The sections to follow deal with the questions raised above starting with a look at ABET program criteria for similar named engineering programs and engineering technology programs.

Table 1. Comparison of ETAC and EAC Program Criteria for Programs with Electrical, Electronic, and/or Computer in their Titles[4-6]

Program Criteria for EET, CET and Similar Programs (Both EET and CET criteria must be met for ECET Programs)	**Program Criteria for EE, CE and Similar Program**
Outcomes (EET or Similar) Graduates of associate degree programs must demonstrate knowledge and hands-on competence appropriate to the goals of the program in: a. the application of circuit analysis and design, computer programming, associated software, analog and digital electronics, and microcomputers, and engineering standards to the building, testing, operation, and maintenance of electrical/electronic(s) systems. b. the applications of physics or chemistry to electrical/electronic(s) circuits in a rigorous mathematical environment at or above the level of algebra and trigonometry. Given the breadth of technical expertise involved with electrical systems, and the unique objectives of individual programs, some baccalaureate programs may focus on preparing graduates with in-depth but narrow expertise, while other programs may choose to prepare graduates with expertise in a broad spectrum of the field. Therefore, the depth and breadth of expertise demonstrated by baccalaureate graduates must be appropriate to support the goals of the program. In addition to the outcomes expected of associate degree graduates, graduates of baccalaureate degree programs must demonstrate: a. the ability to analyze, design, and implement control systems, instrumentation systems, communications systems, computer systems, or power systems. b. the ability to apply project management techniques to electrical/electronic(s) systems. c. the ability to utilize statistics/probability, transform methods, discrete mathematics, or applied differential equations in support of electrical/electronic(s) systems.	These program criteria apply to engineering programs that include **electrical, electronic, computer, or similar modifiers in their title**s. **1. Curriculum** The structure of the curriculum must provide both breadth and depth across the range of engineering topics implied by the title of the program. The curriculum must include probability and statistics, including applications appropriate to the program name; mathematics through differential and integral calculus; sciences (defined as biological, chemical, or physical science); and engineering topics (including computing science) necessary to analyze and design complex electrical and electronic devices, software, and systems containing hardware and software components. The curriculum for programs containing the modifier "electrical" in the title must include advanced mathematics, such as differential equations, linear algebra, complex variables, and discrete mathematics. The curriculum for programs containing the modifier "computer" in the title must include discrete mathematics.
Outcomes (CET or Similar) Graduates of associate degree programs must demonstrate knowledge and hands-on competence appropriate to the objectives of the program in: a. the application of electric circuits, computer programming, associated software applications, analog and digital electronics, microcomputers, operating systems, and local area networks, and engineering standards to the building, testing, operation, and maintenance of computer systems and associated software systems. b. the application of natural sciences and mathematics at or above the level of algebra and trigonometry to the building, testing, operation, and maintenance of computer systems and associated software systems. In addition to the above, graduates of baccalaureate degree programs must demonstrate: a. the ability to analyze, design, and implement hardware and software computer systems. b. the ability to apply project management techniques to computer systems. c. the ability to utilize statistics/probability, transform methods, discrete mathematics, or applied differential equations in support of computer systems and networks.	

Comparison of ETAC and EAC Program Criteria for Programs with Electrical, Electronic, and/or Computer in their Titles

One way to conduct the proper valuation of ET bachelor graduates is to study the program criteria laid out by ABET for similar programs. Table 1 provides a side by side comparison of criteria for programs with electrical, electronic, and/or computer in their titles. An ECET program will need to satisfy both EET and CET criteria. While there are differences in the way program criteria are written up for ETAC (provides outcome guidelines) and for EAC (provides curriculum guidelines) the differences are fairly clear. Table 2 highlights some similarities and differences between an ECET program and an ECE program by deriving from Table 1. *It should be noted that only information that can be discerned from Table 1 has been included. While many of these requirements are well-known in the community it is important to study them from the point of view of ABET.*

Table 2. *Some* Similarities and Differences Between ECET and ECE Programs

Program Requirement	ECET	ECE	Comment
Design of Systems and Software*	Required	Required	
Design of Devices	Not Required	Required	
Analysis of Systems and Software	Required	Not Required	
Analysis of Devices	Not Required	Required	
Implementation of Systems and Software	Required	Not Required	
Application of Project Management Techniques to Systems	Required	Not Required	
Mathematical Requirements	The ability to utilize statistics/probability, transform methods, discrete mathematics, or applied differential equations in support of electrical/electronic(s) systems	Include advanced mathematics, such as differential equations, linear algebra, complex variables, and discrete mathematics. Covers a broader range of topics at greater depth.	ECE requirements are more advanced. ECET requirements are more applied in nature.
Science Requirements	Applications of Physics, Chemistry and other Natural sciences in a rigorous mathematical environment at or above the level of algebra and trigonometry.	Covers a broader range of topics at greater depth.	ECE requirements are more advanced. ECET requirements are more applied in nature.
Hands-on Competence	Required	Not Required	
***For electrical/electronic/Computer systems and software**			

Based on Table 2 according to ABET program criteria ECE degrees requirements include a more comprehensive in-depth coverage of math and science topics; given this math and science background, it can be concluded that a more in-depth theoretical coverage of electrical/electronic/computer areas is possible with ECE programs. ECE programs also allow

for device level design and analysis which is not required for ECET majors. From ABET program criteria, it can be discerned that ECET programs have more stress on implementation and hands-on competence (Table 2). Not surprisingly, Table 2 agrees with Ron Land's paper[1] where he uses survey responses to come up with a similar conclusion,

> *"The majority of responses to this question repeated some variation of the theme that engineers are more theoretical, analytical, and design-oriented while engineering technologists are more hands-on and applications-oriented."*

It should be pointed out that the analysis here bears out the above conclusion when the two programs are compared using ABET requirements.

An important question to ask then is *which of the two degrees is worth more to industry*. The Author thinks that the status quo of "graduate valuation", which currently favors ECE, requires some rethinking. Industry needs both types of graduates and their differences in background can work in favor of the companies that hire them. The author would suggest that equal valuation of both degrees is highly appropriate.

Once again, getting back to Ron Land's paper[1], survey responses from 200 companies who hire both engineers and engineering technology graduates reveal that 70% of them make *"no distinctions between graduates when hiring into engineering positions, nor do they make significant distinctions in assigning functions and responsibilities, nor do they note important differences of capabilities of either group on the job."* This suggests that companies who are better acquainted with engineering technology graduates tend to value them equally with engineers.

Comparison of ETAC and EAC Program Criteria for Programs with Mechanical in their Titles:

The MET and ME comparisons from program criteria point of view is provided in Table 3 for quick reference. Some of the same conclusions can be drawn by more detailed analysis as performed in the previous section and therefore is being left out.

Table 3. Comparison of ETAC and EAC Program Criteria for Programs with Mechanical in their Titles[7-8]	
Program Criteria for Mechanical Engineering Technology and Similarly Named Programs	**Program Criteria for Mechanical and Similarly Named Engineering Programs**
Outcomes The mechanical engineering technology discipline encompasses the areas (and principles) of materials, applied mechanics, computer-aided drafting/design, manufacturing, experimental techniques/procedure, analysis of engineering data, machine/mechanical design/analysis, conventional or alternative energy system design/analysis, power generation, fluid power, thermal/fluid system design/analysis, plant operation, maintenance, technical sales, instrumentation/control systems, and heating, ventilation, and air conditioning (HVAC), among others. As such, programs outcomes, based on specific program objectives, may have a narrower focus with greater depth, selecting fewer areas, or a broader spectrum approach with less depth, drawing from multiple areas. However, all programs must demonstrate an applied basis in engineering mechanics/sciences. Associate degree programs must demonstrate that graduates can apply specific program principles to the specification, installation, fabrication, test, operation, maintenance, sales, or documentation of basic mechanical systems depending on program orientation and the needs of their constituents. Baccalaureate degree programs must demonstrate that graduates can apply specific program principles to the analysis, design, development, implementation, or oversight of more advanced mechanical systems or processes depending on program orientation and the needs of their constituents.	These program criteria will apply to all engineering programs including "mechanical" or similar modifiers in their titles. **1. Curriculum** The curriculum must require students to apply principles of engineering, basic science, and mathematics (including multivariate calculus and differential equations); to model, analyze, design, and realize physical systems, components or processes; and prepare students to work professionally in both thermal and mechanical systems areas. **2. Faculty** The program must demonstrate that faculty members responsible for the upper-level professional program are maintaining currency in their specialty area.

Benefits that come from Proper Valuation of Engineering Technologists

To start, "proper valuation" should be defined for this paper. In this context, proper valuation refers to equal status of engineers and engineering technology graduates both in terms of their ability provide input to a project and also in terms of financial compensation received. While engineers and engineering technologists go through different programs, they communicate well and complement each other in important ways. Following is a list of benefits that can be associated with proper valuation of engineering technologists,

1. Increasing the Number of Engineers in the Workforce: The proper valuation of engineering technologists is likely end in more recruits in engineering technology departments that will eventually end up increasing the numbers of engineers in the workforce. While the numbers of engineering graduates were hovering around 80,000 in 2011, the need for more engineers continues in the face of global competition. Currently, India and China are out producing the U.S. by a factor of 30 to 1[9] in engineering graduates.

2. Providing a much needed diversity of skills in teams: Engineering technology graduates bring much needed skills in implementation and project management[1] as seen in Table 2. Making them coequals in teams with engineers puts them in a position to make important contributions and be heard in a way that is beneficial for the entire team.

3. Ability to be productive right away: Engineering technology graduates have been noted by employers[1] as possessing the ability to become productive more quickly than engineers. This presents an economic advantage that provides another justification for increasing their proper valuation. Companies that are unwilling or unable to provide requisite training to new graduates may prefer to go with an engineering technologist for this purpose.

4. Providing an advantage in a global era[2]: Globalization has certainly caused corporations who do business around the world and *to rethink* the types of skills that are required to maintain an advantage in a global economy[9-13]. One component of global business is product development and manufacturing, an area in which the typical engineering technology graduate is better suited based on their skills in implementation and project management. Yet another reason to properly value their skills.

5. Motivation: Engineering technology students are highly motivated to build and complete projects. In a system that values them equally as engineering graduates this motivation will work in favor of an employer values their skills and provides proper remuneration.

Conclusion

The argument for a fair shake for the engineering technology graduates has been moved in the right direction by Professor Land's[1] survey and analysis. There can be no denying that the academic approaches taken by engineering technology programs are different from engineering programs, but the key argument here is that "what an engineering technologist brings to his/her employer is just a valuable." Table 2 takes a closer look at ECET and ECE programs from the point of view of ABET program criteria establishes how engineering technologists have valuable complementary skills to their engineering counterparts. It is important to note that Professor Land's survey responses from employers agree with the above statement and place a value on these "complementary skills." Also from Ron Land's survey the fact the *70% of the 200 companies surveyed had no problems hiring engineering technologists to engineering positions* is very good news. It seems that people who know them best tend to value them more.

Other benefits that come from a proper valuation of engineering technology graduates are documented in the previous section. Proper valuation can lead to the benefits which can include an increase in the number of engineers in the workforce; more intellectual diversity in engineering teams; a workforce that can be productive right-away; a workforce that is better suited to dealing with the challenges of globalization; and most importantly a workforce that is motivated to provide valuable input.

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