Engineering Versus Engineering Technology: Enemies or Partners

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Abstract

While there are distinct differences between Engineering and Engineering Technology, the boundaries have been ill defined and recent discussions have shown a shift in the views of both sides of the debate which has, in some instances, created conflict.

The fact is that these disciplines when properly defined, do not conflict, but rather supplement each other. It will become apparent that Colleges and Universities which either teach both disciplines or those Colleges and Universities that offer the respective programs in either Engineering and Engineering Technology and which successfully collaborate with each other will offer their students better programs. Furthermore these institutions will be more successful in forging prosperous partnerships with industry.

The paper will analyze the similarities and differences in the Engineering and Engineering Technology curricula and help the reader understand how the combination of these two programs will enhance each other.

Understanding these relationships will allow program directors and curriculum committees to structure their respective curricula to maximize the benefits and to minimize the conflicts when offering both programs. This will result in increased student satisfaction and enrollment, improved economics and better relationships with industry. In addition these programs may also benefit if they are or are seeking to become accredited by ABET.

Examples will be provided how both disciplines can benefit from mutual collaboration and how these collaborate programs can be promoted to attract strong support from industry.

The author anticipates that this paper will initiate an open discussion on both sides for the benefits of students and the profession.

Introduction

Throughout the Engineering and Education Community we engage in a continuous debate that appears to portray Engineering and Engineering Technology degrees as either competitors or significantly different. Regardless of the view taken the outcome is almost always a heated debate that favors one discipline over the other.

Some authors have tried to differentiate the two disciplines as Engineering Sciences and Engineering Technology.[1] At first glance this characterization appears to be a valid differentiation: the Engineering Science focuses on theory and mathematics, while the Engineering Technology focuses on the practical applications of engineering. Yet, the author objects to any reference that equates engineering to be a science. Science by its very definition is based on a solid theoretical framework as is engineering. Yet unlike the sciences, where each problem has a well defined solution, engineering relies often very heavily on the inspirations of the designer and many solutions may exist to address a specific problem as all practicing engineers well know.[2] Engineering

emerged as a craft and it has differentiated itself by applying scientific principles and the understanding of the underlying reasons that the craft is based upon.[3] Yet, it is this author's opinion that engineering may be closer related to a "scientific craft", rather than a purely scientific discipline. Thus, for the purpose of this article we will refer to the terms Engineering and Engineering Technology.

The most obvious difference between the two disciplines which is often raised as an argument in discussions, is the perception that there is a perceived difference in salaries as well as regulatory discrimination: at least 12 states require specifically an engineering degree as a prerequisite for professional licensure and engineering positions within the Federal Government are only open to candidates with engineering degrees and often even advanced degrees, although sometimes professionals with engineering technology degrees and relevant work experience can ultimately gain access to these government jobs.[4,5]

Coupled with a different emphasis on mathematics and theoretical framework, some members of the academic community and of industry conclude that the Engineering Technology degree is a degree of lesser value. Yet nothing can be further from the truth as the following analysis will show.

Engineering and Engineering Technology – a Comparative Analysis

While it is true that differences do exist in the program emphases between Engineering and Engineering Technology, these must be considered objectively and not judgmentally if we truly want to gain a better understanding how these disciplines should interact and that they must be allowed to co-exist as disciplines, potentially maybe even at the same institution as an integral component of a comprehensive engineering program.

Engineering as defined by the Accreditation Board of Engineering and Technology (ABET) is "*The profession in which a knowledge of the mathematical or physical sciences gained by study, experience and practice is applied with judgment to develop ways to utilize, economically, the materials and forces of nature for the benefit of mankind* ".[6] The American Society for Engineering Education's (ASEE) Engineering Technology Council has defined Engineering Technology as "*... the profession in which knowledge of the applied mathematical and natural sciences gained by higher education, experience, and practice is devoted to application of engineering principles and the implementation of technological advances for the benefit of humanity. Engineering Technology education for the professional focuses primarily on analyzing, applying, implementing and improving existing technologies and is aimed at preparing graduates for practice in that portion of the technological spectrum closest to the product improvement, manufacturing, and engineering operational functions.*"[7]

Engineering by its own nature is an applied discipline, even though it encompasses a broad range of highly theoretical research and knowledge. Yet, in the end the final goal is always to develop technologies, means or products to accomplish a specific, very concrete goal.[8,9]

Engineering Technology on the other hand is specifically defined as an applied discipline, which focuses on how to "analyze, apply, implement and improve existing technologies" and ABET defines Engineering Technology as "that part of the technological field which requires the application of scientific and engineering knowledge and methods combined with technical skills in support of engineering activities; it lies in the occupational spectrum between the craftsman and the engineer at the end of the spectrum closest to the engineer."[4,10]

While they are different in scope, both disciplines require the same elements of knowledge and skill although they will vary significantly in their different levels of emphasis and depth.[11]

The main difference in the above definitions appears to be that Engineering Technology focuses on existing

technologies, while Engineering focuses on developing new technologies. However, this view may be too simplistic as it is a stationary definition, whereas the world of Engineering and Engineering Technology are dynamic environments.

First of all, the Engineer must also be a Technologist to be true to the definition of his/her profession and the Technologist must also be an Engineer with the fundamental skills and understanding of the discipline.[12,13] As technology changes both, the Engineer and the Technologist, must adapt through learning and practice of these newly emerging technologies. This can only be accomplished if both, the Engineer and the Technologist, have a solid understanding of the underlying scientific principles of the discipline, although admittedly this understanding can be at different levels of depth. Thus, it appears that from the definitions of the discipline, the only difference between the Engineer and the Engineering Technologist is in the emphasis of the components of specialized knowledge: the Engineer has a broader understanding of the scientific principles and mathematical analysis, while the Engineering Technologist has more knowledge about the state and intricate details of a specific technology and its workings: both of which are valid and legitimate skills and viewpoints.

Which of these skill sets is more valuable? The simple answer is: "it depends". The author had the opportunity to work in a variety of engineering companies with graduates of both Engineering and Engineering Technology, where he was able to observe and evaluate their performance. If a company's survival depends on the successful development of a new product or a new technology, then this task may well require the skills of an Engineer. But, if a company produces 20 million widgets a year and the Technologist can improve the production process and reduce the product cost by merely 10 cents then this will generate significant additional revenues for the company. In most instances a successful company requires both skill sets for its survival.

Those who have worked in industry will most likely have noticed that in the world of the working engineer both skill sets typically do develop. Continuously, some Engineers develop into (often well paid) Technologists, while some Technologists decide to transition into Engineering.[14,15]

Recent salary data published by Purdue University shows that the gap in starting salaries between graduates in Engineering and Engineering Technology is narrowing, while other references cite virtually no differences in starting salaries between Engineering and Engineering Technology. [16,17,18] This is further proof that the job markets requires and values both of these disciplines equally. The author also knows from his personal experience in industry that there are many examples of Engineering Technologists outperforming the compensation of Engineers after they both have been working for several years.

If these natural transitions between Engineering and Engineering Technologies occur regularly in industry and if the two disciplines are so closely related, why is there such a division in the academic world?

The Changing Role of Engineering Education

Nationwide there is a trend to reduce the number of credits required for graduation at the undergraduate level, while the general education core requirements are increased to address a variety of subject areas. As a result the number of credit hours in degree specific education at the undergraduate level has significantly decreased. The credit hours that are still available for subject specific education are often marginally enough to convey the basic principles of the discipline.[19]

Thus, students at the undergraduate level have little opportunity to acquire subjects of interest and to broaden their perspective in the fields of study that they have chosen. Industry, on the other hand, demands graduates who can quickly jump in and become productive and that possess both a research and an applied focus.[20] At first glance the Technologist will have an advantage due to the fact that the Engineering Technology education places

more emphasis on current, existing technologies and skills.

However, two trends are emerging in Engineering Education:

- the requirement by industry for advanced degrees;[21]
- project and team based learning.[22]

During the past 15 years, a trend has emerged that industry is increasingly demanding higher levels of education and the requirement that engineers have completed a Masters Degree is relatively common today compared to the 1970-1980s, when few candidates with Masters and PhD degrees were sought by industry. Enrollments in advanced degrees in Engineering have increased from the mid 1980s with some temporary variations.[23,24] A possible explanation for this trend is the combination of reduced, degree specific education at the undergraduate level while the complexity in the technical fields is increasing, although most of the literature just focuses on stating the differences in compensation without giving specific reasons. Other authors note that advanced degrees are required for a career in teaching at the University/College level. Thus, more time and study is required to adequately become knowledgeable.[25]

The second trend in engineering education is the move towards team and project based learning as a result of several different factors: [26]

- the demand from industry for experience
- the increasing use of media assisted education
- the transition from a "teaching" to a "learning" environment

It is beyond the scope of this paper to explore the above reasons in greater depth. The result is the increasing use of lab based education, team projects and capstone projects in the traditional Engineering Education: thus the Engineering student is directly exposed to Engineering Technology – the application of known technology, and as a result new conflicts emerge between the two disciplines.

In the past, Engineering disciplines have often perceived Engineering Technology as inferior and therefore denied Engineering Technology equal status which has created a great amount of conflict. Now we see Engineering Technology disciplines objecting to the teaching of more skills and technology based education by the Engineering disciplines. Engineering Technology disciplines interpret as invading their exclusive territory.[27] The results are heated discussion, accusations and counterclaims, and a flood of e-mails on the listserv.

The Need for Mutual Recognition and Cooperation

It is now time to focus on the synergies and similarities, rather than on the differences between Engineering and Engineering Technology. It has been established that both disciplines require the same basic knowledge with various degrees of emphasis and in-depth knowledge.

The author believes that there would be tremendous advantages in teaming Engineering and Engineering Technology students for senior projects, especially in light of the fact that industry requires Engineers and Engineering Technologists to work in teams, where each member will contribute with their special skills.[28] The Engineering students will provide the analytical skills and provide great insights to the Technologist about the way designers approach a problem. The Engineering Technologist on the other hand will add the valuable application specific skills and insights about the state-of-the-art of the technology for the Engineers, which are required for a successful implementation of the project's solution. Secondly, such a collaborative effort will expose the students more realistically to the working environment and conditions that they are likely to face if they enter careers in industry.

The advantages are even greater for those institutions that offer both: degrees in Engineering and Engineering Technology. If the institution's faculty now has both skill sets: the Engineer and the Technologist, then both can offer their respective experience to the students in both programs. Those courses that focus on applications should be taught by Technologists, preferably with industrial experience, while the fundamentals of the discipline should be taught by Engineers and/or Scientists, even in the Technology disciplines, which may place reduced emphasis on these skills. This division will maximize the utilization of the faculty, assure a quality curriculum and provide students with the most qualified and relevant instructors. Some institutions do already share courses successfully for Engineering and Engineering Technology, such as Engineering 0011 at the University of Pittsburgh.[29]

The above co-operation does not necessarily imply that both disciplines be integrated into a single School (College) or even Department. Some institutions have attempted to coordinate their Engineering and Engineering Technology programs to supplement each other in different subject areas, rather than to offer the same subject areas in Engineering and Engineering Technology, such as Brigham Young University. This approach may eliminate many of the potential conflicts between the disciplines when they are combined within the same institution. The author merely suggests that some courses, some faculty and especially some labs and senior projects be coordinated and shared to maximize the benefits to the students and for the institution.

Even this concept may be difficult to implement in the traditional structure unless all parties can engage in an open dialogue that focuses on facts, mutual respect, the institutional needs and most importantly – the student.

However, there are incentives for institutions and individuals to seriously consider just that. Industry demands greater cooperation from academia and education.[30] Strengthening the ties between academic institutions, which provide graduates in both Engineering and Technology, and industry can be a rewarding experience for all stakeholders.[31] General Motors (GM), in cooperation with EDS and SUN Microsystems, has made significant investments in selected institutions and programs. These institutions have each received significant financial support in the form of equipment donation and other support under GM's PACE program. To date GM has spent over $1.3b in PACE contributions. Several institutions have received over $100m in contributions individually and GM is committed to continue its support to these programs.[32]

If the institutions can successfully demonstrate the intrinsic value of their contributions and provide practical results as evidence to the participating industrial partners with the help of both, Engineers and the Technologists, then strong, mutually rewarding relationships will develop. Thus, it is in the best interest of both disciplines, Engineering and Engineering Technology, to engage in a true cooperative effort between these disciplines.

Conclusions

The paper has shown that while there are differences in the emphasis that Engineering and Engineering Technology places on specific principles and components that are generally common to both disciplines both disciplines are very similar in many respects. Both disciplines require specialized skills, which are necessary in today's complex technological environment. Individuals often appear to transition from Engineering into Engineering Technology and vice versa during their careers.

Outside the academic institutions the two disciplines tend to complement each other, rather than compete as is often the case in the academic environment and industry increasingly demands that both disciplines co-operate and that Engineers have a better understanding of technology.

To be successful academic institutions must increasingly evaluate their role and mission and seek to combine

both: Engineering and Engineering Technology to structure. Furthermore, the institutions must continuously try to allow for a transition between the two disciplines for students who choose to do so and programs must be designed to meet the demands of students, industry and society in today's technology driven society.

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Dr. Holling is Dean of the School of Computer Science and Engineering at Utah Valley State College (UVSC), where he is involved in curriculum development and accreditation of the School's programs in Computer Science, Engineering and Technology. Dr. Holling has a PhD and a MSEE from the University of Aachen in Germany and an MBA from the University of Wisconsin. Dr. Holling is a Senior Member of the IEEE, a member of the ASEE, SAE, and the President of the Association of International Motion Engineers (AIME). Dr. Holling has been adjunct faculty at Western Michigan University, Kalamazoo, MI and Moraine Park Technical College, Fond-Du-Lac, WI. Prior to joining UVSC Dr. Holling has worked for over 20 years in industry as CEO of AMC Technologies, V.P. Engineering at Regdon, V.P. Engineering at Cordin, R&D

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