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A Life-Cycle Perspective of Engineering Technology Education

Abstract

In higher education the terms engineering and ET (Engineering Technology) are often intermingled and confused collegially and among students. Within the communities of higher education, engineering is most often defined as the science of applying knowledge to design and develop systems and structures, while ET is defined asthe science of applying knowledge to solve a problem. Although ET was spawned from engineering after WWII, it has become aself-sustaining educational system that thrives on technological innovation. This evolution in ETeducation is also the biggest challenge in the ET education arena. Unlike engineering, whose roots are based in timeless sciences,including mathematics and physics, technology is a vast topic that seeks to fill the void between development and application. This defining characteristic results in amalleable educational system that covers many topics and adapts quickly to changing job markets.Often,this can minimize students' exposure to mathematics andclassical sciences. This results in what is regarded in some educational communities as a "light" or a "lesser" educational experience. While this is simply a fallacy, to help avoidthisconnotation, ET educators must identify and incorporate key parameters into their programs. This includesdeveloping a learning environment focused on educationalcomprehensionand knowledge digestion, while avoiding the perils of simply "training" students.This paper discusses ET education from this approach, defineskey parameters, the life cycle of Engineering Technology education, and the differentiation of training and education. To extract and develop this information, the timelines of several ET institutes and their curricular evolution were studied.

1.0 Introduction

The definition of a life cycle can be usedin many different applications. Most commonly, a lifecycle is used to describe a particular pattern of evolution fora product, industry, or organization,to chronicle theirinceptionthroughtheir ending,or to registera transformation into an unrecognizable form. This paper uses a lifecycle perspective of ET (Engineering Technology) education to discuss the history of ET, its role in the educational arena, key parameters that make an effective ET curriculum, and the future of ET.

To truly gain a perspective of the lifecycle of ET education, we must first understand the correlation between the lifecycles of technology and ET education. Importantly, understating the divergence of engineering and ET education as well as their symbiotic relationship, is also a necessity. Coupling these topics leads to the development of parameters, that if carefully examined, yield an accurate perspective of the lifecycle of ET education.

2.0 Engineering and Engineering Technology

In the educational arena, the topic of engineering education versus ET education is passionately debated. Often, this debate is shrouded in misunderstanding, ultimately ending in a declaration of superiority from one side or the other, without regard to the function of the opposing side. Classically, engineering programs teach students to design and develop systems and structures while engineering technology programs teach students to apply knowledge to solve problems.[1] This results in a symbiotic relationship between engineering and ET, not a competitive one. Moreover, the crux of the problem is society's clear understanding of engineers, the history of engineering education, and their function in industry, where applied engineers on the other hand,are often mistakenly associated with technicians (vocationaltechnology graduates), resulting in a murky history and functional role in industry. The following sections mean to demystify and to correct this by reiteratingET's history, providing a comparison of ET and vocational education, and the role of modern ET.

2.1 History of Technology in Education

Establishing an accurate and informative history for technology education is a colossal task. In fact, it is highly improbable that an accurate history for technology educationas a whole could be established. This is due in no small part to the fact many technology programs where created at different times with varying goals.[1] Resulting in many institutions commingling the terms engineering, engineering technology, technologist, technician, and the like, which further exacerbate the process of developing an accurate history. This becomes exceedingly clear during the research of this topic, for example, Purdue's College of Technology.

Purdue University's College of Technology has a deeply rooted and well established history that dates back to the 1870's. Beginning with the Morrill Act of 1862, Purdue began focusing on teaching the principals of applied engineering. However, it was not until WWII when a coordinated effort with the federal government, that the Division of Technical studies was formerly established. Simultaneously, the Technical Division was awarded the ability to grant diplomas based on a two year program. This was an important function as society needed educated individuals to diagnose and apply the developing technology needed for the war effort and society at large. In 1968, the Technical Division was renamed the UEC (University Extension Council), and the Department of Applied Technology was developed as a division of the UEC. This department spawned many new technology departments including electrical engineering technology, mechanical engineering technology, and civil engineering technology. 1964 was the year that the Purdue trusties affirmed a proposal for a new undergraduate school that would ionize all of the universities applied learning programs. This new unified program would be known as the School of Technology until 2005, when it would be renamed the College of Technology.[2]

Based on this example, it becomes easierto see the morphing nature of ET to suit the needs of industry and society. In a sense this becomes one of the key attributes of ET programs, their ability to adapt to the technology lifecycle. It also becomes easierto see how the independent development of technology programs spawned into a "mass" of confusion and misunderstanding that has resulted in lack of any unified history.

2.2 Engineering, Engineering Technology, and VocationalTechnology

Among higher education communities the terms engineering, ET, and vocational technology are often intermingled and misunderstood both collegially and among students. The following discussion serves to help clarify these terms and enlighten educational communities and industry alike.

The most accepted definitions of engineering and ET focus on the differences. Engineering is defined as the science of applying knowledge to design and develop systems and structures, while ET is defined as the application of knowledge to solve problems.[3]While these definitions are accurate, they neglect to point out that engineering and ETshare foundational knowledge and the application of science and mathematics. In fact, as stated, they only diverge in their application of that knowledgeto fulfill their functional roles in perpetuation of the technology life cycle.

Understandingthe differences betweenET and vocational technology is often more opaque and misunderstood than the difference between engineering and ET. Foundationally speaking, vocational technology graduates tend to betrained with a broader technical background.Additionally, a comparisonof vocational technology to ET, finds vocational programs often lessen the exposure of science and mathematics, as well as the level of specializationwhen compared to ET.[4]This makes sense as technicians (graduates from vocational technology programs) are tasked to repair equipment, often without an understanding of the root cause of the problem, or the function of the equipment within the system.

In short, the differences could be summarized with the following example. Complex Fourier analysis is a staple of engineering education, while Sine Fourier analysis is a valued component of ET, and no form of Fourier series is taught in any vocational technology programs.Simply stated, engineering programs use science and mathematics to develop systems, equipment, and structures, ET programs apply science and mathematics to criticallyassess problems and develop solutions, and vocational technology programs teach only fundamental science and math as they focus on repair and maintenance.

3.0 Engineering Technology Education

Building on the foundation laid out by this paper, including establishingET's history, importance to the technology lifecycle, and the symbiotic relationship with engineering programs, one can see the requisitenature ofET. However, understanding the need for ET is not enough. ETprograms do not enjoy the celebrated status of engineering programs. Hence the dire need for special attention to parameters used in ET programs, a keen understanding of the life cycle of ETeducation as it relates to lifecycle of technology, and avoiding the perils of training students versus educating them.

As modern societies level of technology sophistication and literacy increases, the demand for more complex technology ensues. Thus, a driving force of the technology lifecycle, in turn, also drives the ET education life cycle. Modern ET education must develop an understanding of this lifecycle and how it impacts the curricula of engineering technology programs. Evidence suggests many institutions of higher education and their communities are doing just that, from modern disciplines like computer programming and architectural technology, to more traditional programs like electrical and mechanical ET, universities are continually expanding their ET programs to meet the demands of the technology life cycle and the ever changing job market.

3.1 Parameters of ET Education

Traditionally ET education requires the study of mathematics and science, albeit not to the same depth as engineering students. However, ET students must have a more than a fundamental understanding of technology and its supporting elements, more so than a technician.[1]Therefore the model of ET education must be robust and malleable in its design, to provide an opportunity for students to learn about the processes and knowledge related to technology. For this to be possible there are many parameters that must be considered when revamping existing ET programs or creating new ones.

There are a minimal number ofacademic sources offering a complete and exhaustive list of parameters associated with ET education. However, the International Technology Education Association developed a comprehensive list that has received many scholarly citations. As such, this list will serve as the basis for the discussion of key parameters of engineering technology education.

1. Designing, developing, deploying, implementing and utilizing technological systems such as communication, transportation, manufacturing, and construction technologies as an educational base to assess the needs of society and industry.[5]Salinger, (2005) found that “understanding [the] impact of engineering solutions in global and social contexts” and “being aware of contemporary issues” are key parameters to the development of anET program, further pointing to the coupled nature of the technology and ET life cycles.

   Engineering technology programs need to be cognitive of this during curricula development. Following this parameter will allow for the development of industry desired skill sets that will enhance demand for graduates while simultaneously improving the reputation of the university. For example, the development of a course focused on sustainable (green) technology would provide a skill set that is considered desirable by industry, as jobs in sustainable technology continue to grow in the U.S. and internationally.

2. Employing cognitive, manipulative, and affective learning strategies to develop a core understanding of technology.[5]This should include a scientific approach to applying knowledge, critical thinking, and root cause analysis. One of the most direct connections to engineering education, this parameter develops the skills necessary to apply knowledge to solve problems and develop applications for industry.

3. Applying engineering technology knowledge and processes to real world experiences, through internships and high-level on-campus projects.[5] A major divergence between engineering and ET, ET is based on the application of knowledge, hence the need for hands-on projectsin and beyond the classroom.

4. Working individually as well as in a team to solve problems.[5]This applies to technology programs school wide as cross-discipline work will prepare students for the “real world” of engineering technology. Importantly, the combination of parameters three and four should be considered by any ET program wishing to develop effective preparation of graduates for industry. Too often graduates work on projects within groups, or as individuals composing a group, from the same discipline. This defeats the purpose of group work, as students from one discipline,develop similar diagnostic and scientific solutions. Working in a multi-disciplinary environment on projects with a common outcome, will provide the necessary experience required for success in industry where employees will work in groups with dissimilar approaches to problem solving.

5. Incorporating up-to-date technology in the learning process.[5]The use of laptops and the virtualization of hardware make this parameter not only valuable for student’s educational experience, but add flexibility to curricula that may need to change semester to semester.

   Educational communities are often slower than society at adopting new technologies, due impart to the cost of associated infrastructure and the need for faculty to develop new learning material. One example to resolve this is by implementing laptop programs.This provides a dynamic alternative to the ubiquitous static computer lab approach traditionally used by ET programs. Course instructors could update students laptops in real-time as industry releases new technology. Obviously in this example there are other considerations that need to be addressed, such as software licensing and deployment, but none the less, a reasonable result of the implementation of this parameter.

6. Continually revising course content to be ahead of technology trends[5].Tied to the previous parameter, technology changes at a remarkable rate. What is cutting edge theory one

semester is obsolete sixteen weeks later. ETcurricula must be as flexible and dynamic as the technology it aims to create.

7. Performing open-ended, problem-based design activities in both classrooms and lab.[5]This is a very important part of ETeducation. Students often complain that problems worked during lecture are simpler than problems given on tests. Indicating that this parameter is often ignored in curricula development. As test problems are designed to test a student's understanding of theory, this complaint highlights a problem occurring during the transfer of knowledge during lecture and lab. Many articles including New Jersey's Science and Technology University (2010), Salinger (2005), and Pannabecker (1995) offer varying solutions to solve this problem. One common theme among them is the active involvement of students during the lecture. While the classical lecture approach works for theory, application requires a more interactive approach. This can be accomplished through laptops which allow students to work problems simultaneously with the instructor.

While this list is not exhaustive, the included parameters are a necessity in supporting the ETlifecycle and echoing the need for education over training in all ETprograms. Effective ET curricula need to be as unique as their history. Therefore, educators need to develop curricula that serve the ET community. Focusing on a system of education that avoids training in lieu of education. As well as education that focuses on applying scientific methods and mathematical analysis to solve problems, without ascending into a level of theory commiserate with engineering, or digressing into technician level training .

3.2 The lifecycle of ET

To best define the ET lifecycle, it needs to be divided into two relational elements. First is the slinky analogy, which explains the symbiotic relationship between engineering and ET. Second is the relationship between the technology and ETlifecycles.

Technology exists in five stages, creating its lifecycle[6]:

1. Bleeding Edge- where a technology is developed, but has no established value to main stream consumers.
2. Leading Edge- where a technology has begun to be implemented by high-end and power users.
3. State of the Art- where a technology is accepted and deployed by a significant segment of the market place.
4. Dated-when a technology has become widely accepted by main stream consumers, but a replacement technology has entered the market.

5. Obsolete-when a technology is no longer valued by the main stream consumers.

At this point the reader may ask what the correlation or analogous nature of the technology life cycle has with ET education. Simply put, technology has a point in which it has potential, then it has value, finally, the value declines until it becomes obsolete. Similarly, educational curricula has a point in which it has future value, followed by a period where current information is discussed, and concludes with a period in which the information is no longer valuable. For example, teaching FORTRAN to contemporary programming students would have little value. While devoting the majority of a semester teaching electrical ET students the operating principals of electro-mechanical relays would have minimal value. Conversely, teaching mechanical ET students bleeding edge materials science has a high potential value.Based on these examples, it begins to become clear that correlating ETeducation to the technology lifecycle will strengthen the ETprogram, while providing students with the type of skill set needed make thembecome valuable in industry.

It is important to note that although the ET lifecycle demands continuous curricula evaluation and refinement to remain current with the technology lifecycle, the importance of fundamental math and science courses in ET curriculum should not be over looked.

The Slinky analogy is based on the movement of the Slinky toy. The Slinky is a child’s toy, essentially a loose spring that rests in the semi-compressed state.If we were to place the spring on its side and roll it across a flat surface, it would expand and decompress, creating portions of the spring the move ahead or expand away from the other sections. As each section moves in a new direction it pulls the other parts of the spring towards it. This is analogous to new areas of ET education, in effect, representing an expansion creating whole new subsets of, or entirely new schools. Examples include alternative energy, computer, and biomedical disciplines, which were unheard of 100 years ago.They splintered from electrical and mechanical engineering, just as mechanical and electrical ET did. Importantly, all schools of engineering and ET are still bound to each other by the coil of technology, the common thread of engineering and ET schools.

A further dissection of this analogy yields several important facts. First, both engineering and engineering technology share a common thread. This thread represents the shared development and application of technology to improve society, and provides the fundamental basis of their curricula. Second, while engineering designs and develops technology, its application is derived by ET.Logically, this points to the fact that engineering is not solely responsiblefor the perpetuation of the technology lifecycle. Lastly, most often it is ET that develops new disciplines in response to the development of new fields and industry demands. Traditionally, engineering is slow to adopt new fields until their functional roles become more stable. This becomes obvious after carefulanalysisof the history of engineering and ET programs such as the biomedical and computer disciplines.

4.0 Conclusion

This paper is not meant to be exhaustive, merely an attempt to illuminate an often misunderstood and mistreated discipline. ET has a robust, albeit diverse, history and a key role in the deployment of modern technology. Moreover, the role that ETeducation plays in driving the technology lifecycle will continue to grow.To support this, ET curricula will have to become malleable, focused on the principals of education, and attentive to key parameters that will continue to drive its lifecycle and value.

The parameters of technology education serve not only to aid in the design of ETcurricula; they also serve as the building blocks for a unifiedETeducation community.Additionally, the Slinky analogythat defines the lifecycle of ETeducationbecomes the cornerstone of not only effective ETeducation, but cooperation among engineering and ETdisciplines throughout the educational arena. The superiority debate is dead, replaced by the simple understanding that engineering and engineering technology share a common core, but have very different functional roles.

With its rich and diverse history, flexibility to serve the needs of industry and society, and overall necessity to continue the proliferation of technology for the betterment of society, ET education is deserving of the respect and recognition within the educational arena and industry alike.

One way this will happenis by the elimination of the term technologist. The term technologist is only used by a handful of ET programs as a title for their ET graduates. This creates much of the misunderstanding surrounding ET programs. In fact, the Department of Labor has no listing of technologist, nor does the Occupational Outlook Hand Book. Concluding that in order for ET programs to capture their due respect and recognition, the term technologist must be replaced by a more accurate term. It is proposed here that the term “applied engineers” be the new designation for ET graduates. Effectively separating engineers from technicians and creating an accurate distinction of design engineers for engineering program graduates and applied engineers for ET program graduates. The future of ET depends heavily on its ability to adapt to changing job markets, however, it must also be able to identify itself clearly and accurately in order to avoid the confusion that so often surrounds it. The implementation of the term applied engineer andthe development of effective and solid ET curricula are paramount steps to accomplishing this goal and further evolving the lifecycle of ET programs.

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