The Development of Cross Discipline Plans of Study within Existing Engineering Technology Programs to Satisfy Industry Needs

Isaac L. Flory IV, P.E.
Old Dominion University
iflory@odu.edu,

Anthony W. Dean
Old Dominion University
adean@odu.edu,

Nidal Dahman
Old Dominion University
ndahman@odu.edu,

John R. Hackworth
Old Dominion University
jhackwor@odu.edu,

Gary R. Crossman
Old Dominion University
gcrossma@odu.edu

Abstract

Existing Engineering Technology programs that offer degrees in such areas as Electrical Engineering Technology, Mechanical Engineering Technology, and Civil Engineering Technology have typically not promoted cross discipline learning. The development of cross-discipline plans of study offer the potential of greater breadth of knowledge and a customization of skills that are directly targeted towards specific industry needs. Augmenting the student's knowledge base would not only bode well for the academic institution, but also increase the graduating student's marketability at the professional level. An example would include Mechanical Engineering Technology students with additional exposure to electrical power systems via those courses offered in the Electrical Engineering Technology area. Another example would be additional courses in engineering economics for the Civil Engineering Technologist which would assist in developing solid project costing skills. From an industry perspective the less that a newly hired employee has to be trained, the more quickly the employee will begin contributing to the bottom line.

Introduction

Engineering technology is an ever-evolving landscape of needs and desires from the perspective of both the employee and employer. The flexibility of the engineering technologist is a need

across many job functions, however, it is always a desire of employers that their employees be as versatile as possible. Engineering systems are becoming increasingly more complex and many of the repetitive tasks associated with discipline specific job functions have been relegated to the computer. More and more structured or routine problems faced by the engineer can be automated, thus providing the technical professional more time to deal with non-routine problems, which in fact represent the real world [1]. For example, the need for an employee design printed circuit board assemblies as a sole job function is no longer commonplace. The technologist must now be able to develop, design, and in many cases take significant responsibility during the manufacturing process as well. This broadening of responsibilities has been dictated by the increased ability of the technologist to quickly layout and test circuit board designs with the aid of computers equipped with the appropriate hardware and software. In general, engineering technology education has needed to change over the years for a number of reasons including; globalization, rapid diffusion of information, changes in technology, and the convergence of disciplines. There is a blending of the disciplines due to the convergence of science and technology as well as the combination of existing technologies to create new technologies [2].

Knowing all things in a broad field such as technology leads one inevitably down the path of becoming a "Jack of all trades….. master of none", meaning that an individual may demonstrate expertise in one or more areas, but in an attempt to master all areas the results are that the overall level of performance suffers. Engineering technology is a complex field, and being able to assimilate and successfully apply the full breadth of technical knowledge is not normally condoned in a professional environment. There are those in the professional world however that feel that an engineer or engineering technologist should be able to tackle any technical problem that would avail itself. To measure up to expectations technologists must have at least a working knowledge of other technologies so that they may offer solutions to various problems [2]. This impression, along with pressures to reduce product / project costs leads technologists down the path of having to be more versatile and less specialized while maintaining as high a level of expertise as possible.

The question therefore becomes "How does an institution of higher learning address the need for cross discipline fields of study?" One approach which fits well within the structure of most Engineering Technology programs, and is already commonly employed my most colleges and universities is the minor program of study. Engineering and Engineering Technology minors have been successfully administered by many schools for the purpose of broadening student's boundaries. Minors in Engineering Management (ENMA) and Leadership Development have been documented as being popular among students [3][4]. The benefits of offering options outside of the major program of study have also been described [5]. Figure 1 illustrates an example major and associated minor programs of study that could offer students more exposure to varied technology and management areas. Note that there is an intended omission of the link between civil engineering technology and electrical engineering technology. This is due to a less than obvious correlation between the two fields of study.

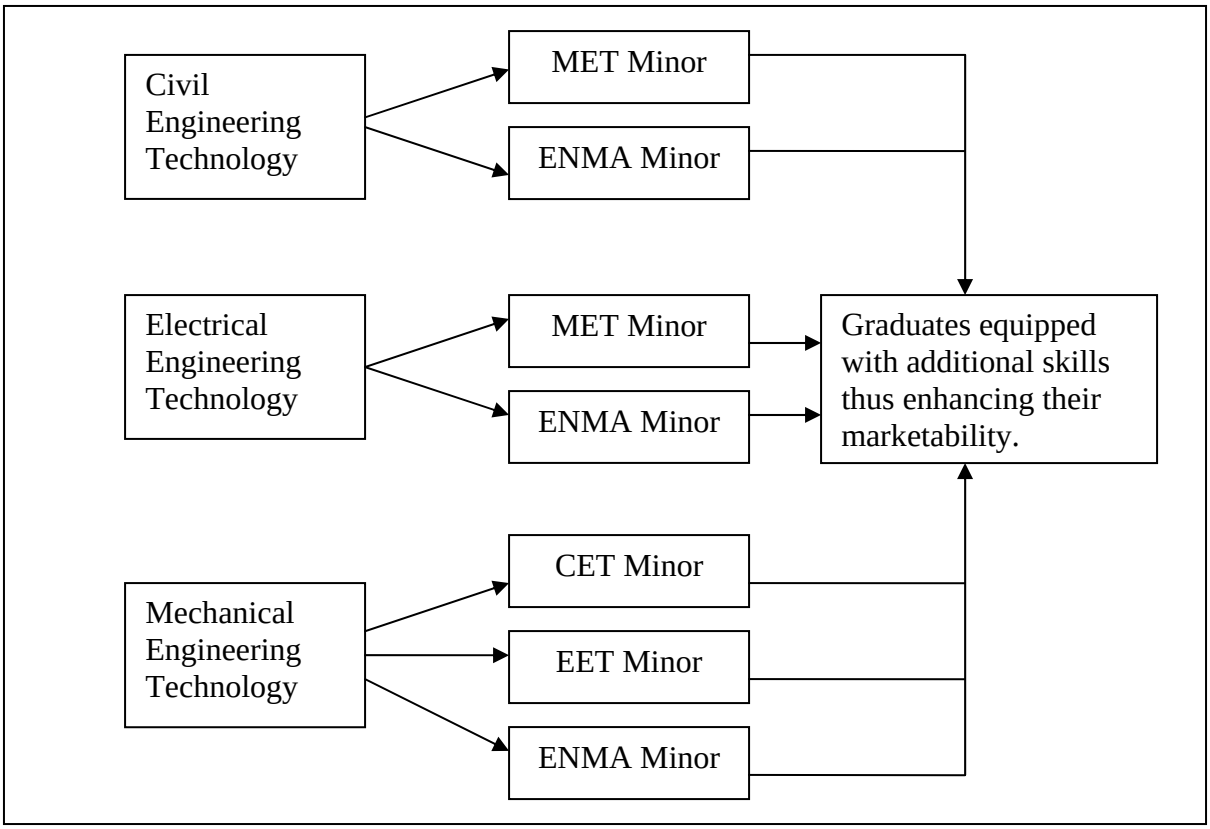

Figure 1: Flowchart of Potential Incorporation of Minor Programs of Study

Systems Engineering

The idea of the systems engineer came about as a result of the ever increasing complexity of technical systems. It is now commonly assumed that a "systems engineer" refers to an information/computer technologist who maintains a computer or communications network, however the title has a broader connotation in the historical sense. System engineering focuses on defining customer needs early in the project or product design cycle, and considers the complete problem: operations, environment, design, development, manufacturing, deployment, cost and schedule, performance, training, maintenance, test and disposal [6]. Historically the practice of having a product or project manager oversee the aforementioned items has been the norm; however it is becoming more common to expect the technologist to take responsibility for an increasing number of these items.

One Example – Old Dominion University

Old Dominion University (ODU) is a comprehensive, state – supported institution with over 18,000 students. The university is located in the Tidewater region of eastern Virginia, a metropolitan area with a population of approximately 1.5 million. ODU has been a pioneer in distance learning through its satellite-based TELETECHNET system that reaches students at 50 off-site campuses (primarily community colleges in Virginia and other states) and through

streaming video. The multiple programs offered at ODU draw a wide range of students, resulting in a diverse student body.

In an effort to provide varying cross-discipline options to its undergraduates, the Engineering Technology Department has developed a number of minors that allow crossover between the varying disciplines [7]. These include:

1. Civil Engineering Technology Minor
2. Electrical Engineering Technology Minor
3. Mechanical Engineering Technology Minor
4. Engineering Management Minor

In addition, there is also a General Engineering Technology option that is structured to offer the student holding an associate's degree in applied science with the opportunity to complete a bachelor of science in Engineering Technology.

Civil Engineering Technology Minor

This minor is subdivided into two categories; construction and geomatics. The construction option allows the student to expand their knowledge base by taking courses in building construction, planning and scheduling, estimating and project management. It is open to all students and requires 12 hours of coursework. All course prerequisites are enforced thus limiting participation by those students outside of engineering and engineering technology programs of study. The geomatics option consists of coursework in the areas of land surveying and photogrammetry. Again, the credit hour investment is 12 course hours with corresponding prerequisite requirements in place. Courses leading to this minor are listed in tables 1 and 2.

Table 1: Courses Fulfilling Civil Engineering Technology Minor (Construction) [7]

Course Number	Credit Hours	Title
CET 310	3	Fundamentals of Building Construction
CET 445	3	Construction Planning and Scheduling
CET 460	3	Construction Estimating
CET 465	3	Construction Project Management

Electrical Engineering Technology Minor

Open to all students other than electrical engineering technology majors, this minor offers the student exposure to the areas of power and machinery, communications, and programmable system controls. In certain cases course substitutions may be made if administrative approval is given. In addition, a survey course covering general electrical theory, power, machinery, analog circuits, and digital electronics is offered as part of the program of study for this minor. As with the other engineering technology minors, 12 hours of coursework are required with all prerequisites being satisfied. The courses required for this minor are listed in table 3.

Table 2: Courses Fulfilling Civil Engineering Technology Minor (Geomatics) [7]
(* - Photogrammetry concentration)

Course Number	Credit Hours	Title
CET 305	3	Principles of Surveying
CET 320	3	Adjustment Computations
CET 313 or CET 412*	3	Advanced Surveying / Elements of GIS
CET 318 or CET 416 or CET 421*	3	Control-GPS Surveying / Geodetic and Astronomical Surveying / Adv. Analytical and Digital Photogrammetry

Table 3: Courses Fulfilling Electrical Engineering Technology Minor [7]

Course Number	Credit Hours	Title
EET 350	3	Fundamentals of Electrical Technology
EET 360	3	Electrical Power and Machinery
EET 410	3	Communications Principles
EET 415	3	Programmable Machine Controls

Mechanical Engineering Technology Minor

This distinction is available to all students other than those majoring in mechanical engineering or mechanical engineering technology. Areas of study include thermodynamics, mechanics and dynamics, as well as fluid dynamics. The only requirements are that the student have a grade point average of no less than a 2.0, and has taken at least one 3 hour calculus course. For those undergraduates not majoring in mechanical engineering or mechanical engineering technology who are planning upon taking the Fundamentals of Engineering Examination leading towards future certification as a professional engineer, this minor is particularly attractive. The courses required for this minor are listed in table 4.

Engineering Management Minor

This minor has become a popular option due to its focus upon those skills which are perceived as having value at the managerial level. It is targeted towards those students majoring in engineering, engineering technology, computer science, mathematics, or any of the other physical sciences. Students from other areas may also take courses to satisfy requirements for

Table 4: Courses Fulfilling Mechanical Engineering Technology Minor [7]

Course Number	Credit Hours	Title
MET 300	3	Thermodynamics
MET 305	3	Fundamentals of Mechanics
MET 310	3	Dynamics
MET 330	3	Fluid Dynamics

the minor however they are encouraged to consult with advisors in their major area of study. The goal of this minor is to develop skills in team building interpersonal communications, decision making, project management, leadership and quality assurance. There is an expectation that written communication skills are sufficient to adequately support numerous written assignments and papers in the satisfying of course requirements. Also, oral presentation competency is a requisite since communication in the workplace is critical to a company's success. As is the case with the other minors listed, there is a 12 hour requirement along with a minimum of a 2.0 grade point average.

Table 5: Courses Fulfilling Engineering Management Minor [7]

Course Number	Credit Hours	Title
ENMA 301	3	Introduction to Engineering Management
ENMA 302	3	Engineering Economics
ENMA 401	3	Project Management
ENMA 420 or ENMA 421	3	Statistical Concepts in Engineering Management / Decision Techniques in Engineering

General Engineering Technology Major

This program of study is intended for those students who have an associate's degree in applied science (A.A.S.) from a community college. For those students who are looking towards employment in technical management, information systems, manufacturing technology or industrial engineering technology, this program offers a way to develop those skills above what is realized at the A.A.S. level of study. The student may specialize in a number of areas including electromechanical systems, geomatics and GIS, computer and network operations, automation and control systems, technical operations management and construction management [8].

Minors Outside Engineering Technology

For those students wishing to broaden their horizons beyond the study of technology, there are options to pursue minors in business such as economics, finance, and marketing. Although not a new educational option, these areas have proven over the years to be marketable in the workplace, especially when coupled with a technical degree. Additionally, the pursuit of

graduate degrees in any of these areas could also prove beneficial to the individual entering the workforce.

Conclusion

Not only is there a need for the engineering technologist to gain greater knowledge to keep pace with advances in engineering and science, but there is also a need to broaden their knowledge in other areas of technology. Common expectations are that engineering and engineering technology professionals should be adept in dealing with a variety of technical issues from both within and outside their specific areas of expertise. One way to address these challenges is to develop and promote within a university's framework the means for providing students with cross-discipline learning opportunities. The offering of undergraduate minors in other areas of study helps to provide incentive to those students who may question the benefit of such a course of study, as well as provide structure for the expansion of the student's knowledge base.

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Biographies

ISAAC L. FLORY IV, P.E. is an Assistant Professor of Engineering Technology at Old Dominion University, teaching courses in power systems, electronics and analysis. He received B.S. (1984) and M.S. (1993) degrees in Electrical Engineering from Virginia Tech and is currently pursuing his Doctorate from the same institution (a.b.d.).

ANTHONY W. DEAN is Assistant Professor of Engineering Technology at Old Dominion University. He received a Ph.D. in Engineering Management and a B.S. in Engineering Technology from ODU. Additionally, Dr. Dean received an MBA from the College of William and Mary.

NIDAL DAHMAN is currently the coordinator of the surveying engineering and Geomatics program at ODU. He holds a Ph.D. in civil and environmental engineering from the University of Wisconsin-Madison. He is a certified Photogrammetrist by the American Society of Photogrammetry and Remote Sensing (ASPRS). He is also ASPRS certified as a remote sensing mapping scientist and a GIS/LIS mapping scientist.

JOHN HACKWORTH is Program Director for the Electrical Engineering Technology program at Old Dominion University. He holds a B. S. Degree in Electrical Engineering Technology and a Master of Science Degree in Electrical Engineering, both from Old Dominion University. He is the principal co-author of the text Programmable Logic Controllers: Programming Methods and Applications, published by Prentice-Hall.

GARY R. CROSSMAN is Department Chair of Engineering Technology and Professor of Mechanical Engineering Technology at Old Dominion University. He holds a Bachelor's degree from the U.S. Merchant Marine Academy and a Master of Engineering degree from Old Dominion University.