AC 2011-1404: CREATING A NEW 4-YEAR DEGREE IN ENGINEERING TECHNOLOGY

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Creating a New 4-year Degree in Process & Systems Engineering Technology

Abstract:

The BS in Manufacturing Technology program at our university was originally started in 1999, and the name of the program was changed to the BS in Industrial Engineering Technology (IET) program in 2006. Recently, the state university system, that has our university along with 16 other universities as its constituent universities, flagged the IET program as a low productivity program. The faculty and the Industrial Advisory Board (IAB) for the program were asked to provide recommendations as to whether the program had the potential to grow in the coming years, or whether it should be phased out.

The faculty and the IAB on discussion and research have determined that a program in engineering or engineering technology with the name "manufacturing" or "industrial" in it is not looked upon favorably by students and parents. This can be attributed to the general perception that manufacturing happens in dingy, dirty and dangerous places. This perception has also caused many US universities to close down manufacturing and industrial engineering departments in the last decade. Based on research, informal surveys with students and parents, and input from the IAB, that faculty decided to change the name of the program to BS in Process and Systems Engineering Technology (PSET).

Globalization initially lured many manufacturers into setting up shops to manufacture their products overseas and ship them back to us. However, many have realized that this trend cannot continue forever. Initially, there was a substantial labor saving in making parts overseas and importing the fully assembled product, but over time the cost of shipping, the cost of holding additional inventory, problems in communications, and loss of quality in products made by off-shore suppliers has been on the rise. The best compromise that many manufactures have begun to resort to is to procure components from all over the world, and assemble them into customized products for specific customers in the US. This trend, along with substantial inflation in wages and benefits in developing countries like China, Mexico, Brazil and India are beginning to erase the fundamental reasons that manufacturers went off-shore in the first place.

Based on this, the faculty and the IAB for the program concluded that product design will be conducted in the US, parts will be farmed out to be manufactured all over the world, and then the parts will be assembled back here into specific products for specific customers. This will create a growing demand for product designers who are specialized design engineers, and also will create a higher demand for qualified people who can take these designs and work with suppliers to get parts manufactured in overseas factories. Also, there will be a need for qualified people who can set up automated and manual assembly systems to assemble products in the US, and for people who can run these factories by doing problem solving and critical thinking on a day-to-day basis. For such jobs, graduates from the proposed BS in Process and Systems Engineering Technology (BS-PSET) will be ideally suited.

In this paper, we provide justification for developing the body of knowledge for a BS-PSET program, and provide recommendations as to how to move ahead with accreditation for such a

program along with a consideration of sources from where to procure an external evaluation exam for the program.

Introduction:

The University (XXX) since 1999 had a bachelor's degree in manufacturing technology (BS-MT), which was changed in 2005-06 into a bachelor of science degree in Industrial Engineering Technology (BS-IET). This was to weather the discontent of the general public to anything associated with manufacturing. During this time, the US peaked in outsourcing manufacturing jobs and this reduced the number of applicants applying to the BS-MT program drastically. During the time when the university was considering the BS-IET program, there was no calculus-based program in engineering or technology at XXX, and hence it was decided to structure the BS-IET program based on calculus. The major changes made to the program then were to:

1) Remove 4 manufacturing based courses from the curriculum
2) Include a basic math course in calculus that included derivatives and integrals
3) Introduce a course in strength of materials and statics which was calculus-based
4) Introduce a course in basic operations research and simulation
5) Include a capstone course

After trying out these changes for a period of over 4 years from 2006 to 2010, it was felt that even with the new changes the program was not attracting the number of students needed to make it sustainable as the number of enrolled students as of Fall 2010 stood at 34. The program was flagged for reevaluation in Fall 2010 and was given the following three options [1]:

1) Restructure the program by combining it with one or more other campus programs
2) Actively investigate collaboration with other state-wide university campuses in order to conserve program resources and increase course enrollments
3) Discontinue the program while assuring graduation for any currently enrolled students

Discontinuing the program and utilizing the faculty for a more productive program was a very attractive proposition. However, this option was quickly ruled out based on a study conducted a couple of years back by the Associate Academic Dean of the College of Technology and Computer Science. Based on this study, it was realized that the BS-IET program was deeply embedded with other technology programs in the Department of Technology Systems (TSYS) through the sharing of common courses, and that even if the program was totally eliminated it will only save the college $15,000 per year. This is minuscule compared to the over $10M budget of the College of Technology and Computer Science.

The Department of TSYS in which the BS-IET program is housed, responded by saying [1]:

> The IET program is important in and of itself and as a component of this department's and the college's support of the university's mission [2], the XXX Tomorrow Initiative [3],

and the XXX Tomorrow Initiative [4]. The BS-IET program deserves the support and funding of this department, college and university.

The number of students in the BS-IET program as of November 2010 was 34 students. These were distributed as follows: seniors: 7, juniors: 9, sophomores: 5, and freshmen: 13. The program faculty had already begun to work on improving enrollment levels, which was shown by the increase in the freshmen level. The IAB for the program was also involved in these efforts and began suggesting specific ideas to the faculty to increase enrollment. Based on the fact that the first 3 graduates from the new BS-IET program with the updated curriculum only graduated in May 2009, it was argued that more time needs to be given to the program to see results of enrollment efforts.

Based on the above justification, the NC university system has allowed the program to exist up to 2012 by showing specific enrollment gains.

History of the BS-IET Program at XXX:

Initially when the BS-IET program was created in 2006, there was no engineering program at XXX. However, since 2006 XXX has established a Department of Engineering which was created as part of the Department of TSYS. Like all engineering programs, this program is calculus-based, and is designed for students who prefer taking "pure" engineering courses that are calculus-based. In evaluating the BS-IET program, we believe that there is duplication in the engineering and BS-IET programs in the sense that both of these strive to be calculus-based, and we felt that we may serve the student population better by converting the BS-IET program into an algebra-based program.

Discussions with the Department of TSYS' advising center also indicated that the engineering program is a good option if a student wants to go into a calculus-based engineering environment. However, there is no adequate recourse for a student who is mechanically inclined with an interest in using his or her own hands to create products and processes, and who is able to handle college algebra and geometry, but not calculus. This gave us the motivation to pursue converting the BS-IET program into an algebra-based program.

All technology programs in the Department of TSYS are accredited by the Association for Technology, Management and Applied Engineering (ATMAE), and since they are all algebra-based, we additionally felt that it would be best for the BS-IET program also to be algebra-based. Taking all of these facts into consideration, we decided to do a reevaluation of the niche that the BS-IET program presently serves. Also, based on the issues we discussed regarding the name manufacturing or industrial being a part of the program, we evaluated whether a name change along with necessary changes in the body of knowledge was warranted for the program or not.

Identifying the Platform for the BS-PSET Program:

The first thing we looked into was how engineering technology is defined. The best definition we found on engineering technology was from the Accreditation Board for Engineering and Technology (ABET) [5], which defined engineering technology as follows:

> *Engineering technology is the profession in which knowledge of mathematics and natural sciences gained by higher education, experience, and practice is devoted primarily to the implementation and extension of existing technology for the benefit of humanity.*
>
> *Engineering technology education focuses primarily on the applied aspects of science and engineering aimed at preparing graduates for practice in that portion of the technological spectrum closest to product improvement, manufacturing, construction, and engineering operational functions.*

Broadly, engineering technology can be defined as the application of engineering principles and modern technology to help solve or prevent technical problems. We also felt that it was important to understand the social structure of science, technology, engineering and mathematics in order to understand the need and best fit for the new BS-IET program for the Eastern North Carolina region. Several years back, students wanting to pursue higher education after matriculation had only 3 choices:

1) Choice 1 was to pursue an option from among the pure sciences, such as physics, chemistry, or biology. These majors in the present context are only appropriate for people interested in pursuing additional degrees, laboratory research, or careers in education.

2) Choice 2 involved selection from among the engineering science majors like civil engineering, electrical engineering, or mechanical engineering. Engineering requires highly developed analytical skills and prepares people for careers in conceptualizing and designing technical devices and systems.

3) Choice 3 was to enroll in a technical or vocational school. This route is best suited for people interested in the trades; that is, for people who want to pursue careers by physically working to build, operate, or repair machinery.

Considering the expanse of technology in every field, especially fields like robotics, automation, processing, etc., it becomes evident that more personnel are constantly needed to install, maintain and run factories with such technologies, and a new skill set for the engineering technologist can be created which includes the following:

1) Skills to understand some theory behind process, but with a mindset for its easy implementation and maintenance
2) Hands-on practical skills to improvise using knowledge from multiple fields to solve problem on a day-to-day basis on a production floor
3) Be able to grasp issues in processes and lead teams with diverse background to conduct problem solving.

4) Be able to explain how to achieve the solutions in an easy manner to associates with a high school or below education
5) Be able to motivate front line people who produce the actual products and provide services

In researching, we found that the best Classification of Instructional Programs (CIP) Code for the kind of program that we are attempting to create would be:

> *15.9999 Engineering Technologies and Engineering-Related Fields, Other.*
>
> *Process and Systems Engineering Technology: A program that prepares individuals to apply basic engineering principles and technical skills in the:*
>
> 1) *improvement of processes in production and service environments. Includes instruction in process improvement, production line operations, inventory control, operations management, work planning and quality control, and*
> 2) *establishment of systems. Includes instruction in systems analysis, electronics and instrumentation, computer-aided design and manufacturing, programmable logic controllers, electric, hydraulic and pneumatic control systems, robotics, and automation.*

In achieving the above, engineering technologists will need to work closely with engineers who have designed the system and assist in the coordination of people, material, and machinery to achieve specific goals of a particular project. The engineering technologist may be responsible for the design and development of an entire system, and may work independently of engineers to achieve compliance with a desired set of technological specifications in many cases. The engineering technologist may also create the technological specifications by working with customers and translating their needs into a technological product, to help the engineer come up with a design.

In exploring this, it was realized that it will be best if the program can create graduates with two types of knowledge bases that will be well accepted by local industry, namely systems and processes. The faculty felt strongly to create curricula based on the both of these with the realization that diverse faculty skills will be needed to teach. Overall, it was decided that the program should include the following:

1) General studies: In this area, students will round out their general knowledge preparation begun in high school. Any remedial courseware required to bring students up to a general level of excellence will be accomplished here. Since entry into the engineering technology program requires a specific general level of competence, remedial courseware to bring students up to that level will not be included as accredited courseware for the engineering technology degree. Courseware that is included takes up areas such as advanced programming, (including but not limited to: Minitab, Matlab, Labview, etc.), project management, team leadership, research methods, technical writing, etc.

2) Science: This area comprises the courseware that strengthens the student's basic understanding of science and the environment that student will be designing and building in. Courseware should include at a minimum, physics, chemistry, material science and biology.

3) Mathematics: Mathematics is the mortar that bonds science, engineering and technology. An engineering technology student should have at a minimum, college algebra, and trigonometry.

4) Technology: This general area builds the student's practical knowledge base and enables the student to apply science and engineering concepts to real world problems and situations. Courseware in this category should include but not be limited to computer numerical control (CNC), computer aided drafting (CAD), basic electricity, electromechanical systems, robotics, thermodynamics, fluid power, computer integrated manufacturing (CIM), quality assurance, statistical process control (SPC), process control, plant layout, industrial supervision, manufacturing systems planning, and advanced manufacturing systems. Lean six-sigma philosophy and thinking is today the universal tool that everyone is looking toward to help eliminate waste and reduce variation in all types of processes. Major stress will be put in demonstrating to students technology applications for conducting process improvement using Lean six-sigma principles and techniques.

5) Engineering. This area should include total systems integration, static and strength and materials, advanced electronics, robotics, lean and green manufacturing methods, energy conversion, and a capstone course. As the economic environment changes and other engineering technology programs are brought on line, new courseware will need to be added. Additionally, this model may be followed most efficiently by creating a core set of courses that are common to all engineering technology programs. It is the creation of this core set of courses that is vital to the successful application of this engineering technology model.

Proposal for the New Program:

The new degree in Systems and Process Engineering Technology will require a total of 126 semester credit hours, and will have the following specific courses which address the requirements listed above:

Foundations Curriculum:

The first part will be foundations curriculum requirement which will have the following:

a) ENGL 1100 Composition
b) ENGL 1200 Composition
c) HLTH 1000 Health in Modern Society
d) EXSS 1000 Lifetime Physical Activity and Fitness Lab

e) COMM 2410 Public Speaking or COMM 2420 Business and Professional Communication
f) Humanities Elective
g) Humanities or Fine Arts Elective
h) Humanities or Fine Arts Elective
i) ECON 2113 Principles of Microeconomics
j) PSYC 1000 Introductory Psychology
k) PSYC 3241 Personnel and Industrial Psychology
l) Social Science Elective (other than PSYC)
m) PHYS 1250, 1251 General Physics with Lab
n) PHYS 1260, 1261 General Physics with Lab
o) Two electives

Major Requirements

The major requirement will be based on two parallel paths: one for systems engineering technology that includes electronics, hydraulics, pneumatics, robotics, automation, CNC machining, CAD design, etc., and the other path for process engineering technology that includes Lean manufacturing, operations management, work methods and time study, statistical process control, six-sigma, etc. The individual courses selected for making up the new degree will include the following:

a. DESN 2034, 2035 Engineering Graphics I with Lab
b. DESN 2036, 2037 Computer-Aided Design and Drafting with Lab
c. IENG 2020, 2021 Materials and Processes Technology with Lab
d. IENG 2076, 2077 Introduction to Computer Numerical Control (CNC) with Lab
e. IENG 3020, 3021 Introduction to Computer Integrated Manufacturing with Lab
f. IENG 3300 Plant Layout and Materials Handling
g. IENG 3600 Statics and Strength of Materials
h. IENG 4020 Manufacturing System Planning
i. IENG 4023 Advanced Manufacturing Systems
j. IENG 4024 Total Systems Integration
k. IENG 4200 Work Methods and Ergonomic Analysis
l. IENG 4900 Capstone
m. ITEC 2000 Applications of Computer in Industrial Technology
n. ITEC 2054, 2055 Electricity/Electronics Fundamentals with Lab
o. ITEC 2080, 2081 Thermal and Fluid Systems with Lab
p. ITEC 2090, 2091 Electromechanical Systems with Lab
q. ITEC 3290 Technical Writing
r. ITEC 3292 Industrial Safety
s. ITEC 3300 Technology Project Management
t. ITEC 3800 Cost and Capital Project Analysis
u. ITEC 4293 Industrial Supervision
v. ITEC 4300 Quality Assurance Concepts
w. CHEM 1020 General Descriptive Chemistry
x. ITEC 3200 Introduction to Statistical Process Control

y. MATH 1074 Applied Trigonometry

Issues with a Bearing on the Creation of the New BS-PSET Program:

Two additional issues that were identified as extremely important in the structuring of the program were the selection of the accreditation agency for the program and the selection of the certifying exam that will be utilized as an external evaluation for the program.

Accreditation Agency:

The two options for the accreditation agencies were the Accreditation Board for Engineering and Technology (ABET) and ATMAE. ABET has the Technology Accreditation Commission (TAC) which accredits industrial technology and engineering technology programs, and ATMAE has recently begun to accredit engineering technology program which are algebra-based.

Initially, ABET was considered to be a good choice as an accreditation entity as they were the only one to have an outcome based accreditation model. For the BS-PSET degree, the overall outcomes for the program and the course competencies for the individual courses were created based on the ABET model. However, recently ATMAE also started offering accreditation based on the outcome model as an option for this year, which would become a requirement over the next couple of years.

As the other programs in the department of TSYS were all ATMAE accredited and as they also were gearing up to adopt the outcome based model when they come up for re-accreditation in 2012, it was decided to go with ATMAE as it would give the program the best of both worlds: the program can be an outcomes-based accredited program, and at the same time be accredited along with other programs in the department.

External Examination for External Assessment:

ATMAE requires an external exam to be used by all programs to show proficiency in the body of knowledge. For this, the following external exams were considered:

1) The Certified Manufacturing Technologist (CMfgT) exam offered by the Society of Manufacturing Engineers (SME) [6]
2) The Certified Industrial Technologist (CIT) exam offered by ATMAE [7]
3) The Certified Plant Engineer (CPE) exam offered by the Association for Facilities Engineering (AFE) [8]
4) The Certified Manufacturing Specialist (CMS) exam offered by ATMAE [9]
5) The Project Management Professional exam offered by the Project Management Institute (PMI) [10]

Looking at the body of knowledge that was proposed to be covered in the degree based on the requirements shown above, it was felt best to go with the CMfgT exam. An option that can be

offered to the students might be the CMS exam by ATMAE. Apart from the fact that it has a minimum cost to appear, the CMfgT exam covers most of the courses identified for the BS-PSET program the best. This decision was also motivated by the fact that the Department of TSYS at XXX has had a student SME chapter for a long time which operates in close conjunction with the SME senior chapter.

Conclusions:

It is anticipated that changing the name of the BS-IET program to BS-PSET program will induce students who feel their calling is engineering but who are not up to the requirements of calculus to find a great option to pursue toward a fulfilling career in technology. The program faculty will be monitoring the types of students accepted into the program closely for the next 3 years to understand their motivation and preparation in being attracted to the program. It is also hypothesized that even if manufacturing and industry move away from our region, the graduates from the BS-PSET program will have sufficient preparation to find jobs in the diverse multi-industry business world of tomorrow. Monitoring our graduates over the next decade as to the type of jobs that they will get and hold will give us a better picture of how to make modifications to the curriculum plan.

It is the fervent hope of the faculty that structuring the program as proposed into the BS-PSET program, will allow graduates to be good industrial skills in high demand like automation, basic CAD design, robotics, pneumatics, hydraulics, CNC machining, etc., and also produce graduates who have the background and preparation to take any process and analyze it to improve it in terms of productivity and profitability. Lean Six-sigma is today the universal tool that everyone is looking for to use to eliminate waste and reduce variation in all of their processes.

The promise of the proposed program to create graduates with dual skills of systems integration through electronics, pneumatics, hydraulics, programmable controllers, etc., and process improvement skills for improving the value-added content of work for customers through the use of lean six-sigma, is the ardent hope of faculty to provide local industry with graduates who can be hired in multiple industries like: manufacturing, production, assembly, banking, insurance, health-care, construction, etc. How well this vision comes to fruition now rests on how well the proposal is received by university personnel, and what resources are made available to the faculty to implement it.

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