ENGINEERING TECHNOLOGY COLLABORATION WITH INDUSTRY

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ABSTRACT

How can we effectively meet the needs of student and industry? We can provide the engineering technology student with a comprehensive design experience that closely matches that encountered by professional design engineers. And we can seek to develop those communication skills that are an inherent and vital part of engineering activity.

Let us begin by examining the professional functions of an engineering technologist upon being given an open-ended design project. The ET will invariably work in a design group; will initially research the project fully; will create and consider several possible design paths; will prepare a Design Proposal and Cost Estimate that is subject to (client) approval; will carefully schedule the project work which may include prototyping; will prepare formal Progress Reports; may develop a prototype; will stress-analyze and help prepare the design drawings; will prepare a comprehensive Final Design Report; and will present the project results to his/her peers, the engineering organization and/or the client.

Those noted comprehensive design experiences have been practiced by the writer at several universities and, more currently, at Eastern Michigan University. They have enabled us to partner with industry in many major design projects. And they have allowed us to develop our cooperative educational program as well, because the sponsoring organization finds that our students have an excellently-prepared background in providing the necessary functions expected in an engineering technology student.

Finally, the writer has recently researched and published articles on the future practices in Engineering Technology. Some of the research included contacts with industrial sources to learn what they recommend – and expect – from our ET programs in the near future. Their recommendations help us to plan and develop our ET programs more effectively for more successful partnerships.

KEY WORDS: Academia, Industry, Collaboration, Engineering Technology, Design

INTRODUCTION

The desired end product of an undergraduate engineering technology program is quality raw material for industry. Therefore we have to address the needs of the industrial sector and provide an academic environment that satisfies not only a disciplines' technological requirements but also the demands of the marketplace. Consequently, engineering technology programs should be conceived, structured and implemented accordingly.

The writer entered the teaching profession after a significant experience in industry and has been involved since with the development of engineering and engineering technology programs that will directly address the needs of industrial practice. At the onset of his academic career, the writer conducted a comprehensive industrial survey to determine if a particular company's technical expectations and requirements were being met with recent mechanical engineering undergraduates. Following are a sampling of industry's comments and concerns from that initial survey.

> "The engineer is prepared with fundamentals, but doesn't know how to put it together."
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> "The single attribute that young engineers tend to lack is the ability to communicate in clear, concise terms their ideas, thoughts and results. This is generally left for them to learn in actual practice."
>
> "Actual, practical, 'hands-on' experience would complement academics – a co-op situation maybe?"
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> "I have interviewed significant numbers of prospective mechanical engineering graduates, both Masters and Bachelors degrees. I am more prone to give increased consideration to those people who have had a significant course in design, associated with a one-term or two-term project."
>
> "Very few have any training or experience in graphics and in a production oriented company this is a necessity in order to communicate with manufacturing or the various experimental shops."
>
> "Most engineering graduates have the biggest problem in communication – written and oral."

One could hardly browse through an engineering journal without noting articles expressing concern with the current education of our undergraduates. Foremost is the concern that incoming engineering faculty typically have little or no experience in design, yet they are the ones frequently expected to teach design courses. Additional critical comments stated that engineering as it is taught in colleges, and engineering as it is practiced in industry, are quite different; and that engineering students currently join industry with a flaw – the missing design element that they must learn through apprenticeship.

Fundamental skills and learning aids can be implemented at the freshman level and developed further throughout the curriculum to provide a basic format that will link the engineering and design skills necessary for immediate industrial application following graduation. This paper will describe the methods developed and employed by the writer to gain outstanding partnership with industry, principally from a mechanical engineering technology frame of reference.

PROGRAM DEVELOPMENT

The entering student assumes and expects that all curricular effort is focused upon the sole purpose of a particular undertaking, namely, (mechanical) engineering technology. However, present curricula consists of courses offered early in the program that are unrelated to each other. Further, the engineering technological process, which builds upon these primary courses, are not clearly defined until late in a baccalaureate education. This lack of connectivity extends beyond subject content to the professional functions expected of an undergraduate student. Although each of the noted subjects can be developed to stress its unique involvement and usage in the program, there is a more appropriate and inclusive way that the subject matter can be developed and coordinated to enlighten the student at the outset of the academic effort and provide the necessary and desired professional skills and attributes. For example, the entering students can be exposed to a multi-dimensional course whose basic purpose is to efficiently provide not only an understanding of what is involved in the 'design process' performed in industry, but also the opportunity to develop and employ those design functions and skills at the very outset of the students' undergraduate experience.

<u>The Freshman Year : An Introduction to Design</u>

Starting in the freshman year, the engineering technology student is introduced to decision-making skills in a Guided Design course, an organized method that teaches the student to use his/her own initiative; to think logically; to gather information; to communicate ideas; and to solve meaningful, open-ended design problems within a group context. Each design project provides a creative opportunity for students and such activity includes progress reports, oral group reporting and a comprehensive, chronological development culminating in a written report with full graphical and bibliographic elements. Several of the design projects that have been developed in the freshman guided design program are shown below. The average duration of each project was five weeks.

- <u>Self-Contained Speakers Podium.</u> Design an all-purpose, portable podium that has built-in facilities for professional lectures.
- <u>Access to Campus Facilities.</u> Survey all buildings and campus facilities to determine accessibility to the handicapped. Provide recommendations.
- <u>Student Dorm Design</u> Redesign the dorm room to satisfy specifications that would enhance the rooms' functions and comforts.
- <u>Manufacturing Process Review & Redesign</u> Review several manufacturing processes and redesign a given part to suit each process.
- <u>The Ideal Classroom</u> Starting with your present classroom, create an environment to suit your concept of teaching and learning.
- <u>Automatic Opening and Closing Gate</u> Operation is solely mechanical and must open and close from either direction for a specific vehicle.

Within each design project we expect the student/designer to initially engage in, and develop, the following activities: 1. What do I have to learn about a system of this type in order to proceed with, and subsequently develop, a satisfactory and useful design? 2. Where can I obtain information about those items/specs with which I am unfamiliar? And, 3. What design procedure would be most suitable to achieve a solution? As ideas are being formed for a project, the student will find that he/she is: learning to visualize solutions; becoming familiar with 'scale'; gaining an appreciation of weight and strength; developing and expressing ideas graphically; researching the specifications and augmenting them if necessary; and communicating these various components both orally and in writing.

The introductory freshman design experience has been found to nurture an awareness of and interest in further pursuing the formal course structure in engineering technology. The functional outline developed in this program provided a direct method for continuing that effort throughout the remaining undergraduate years. The continuing design activities are described below.

Continuing Design Program

The engineering technology program, by virtue of its hands-on approach to technical application and reasoning, helps to develop a realistic foundation for extending the design effort throughout the curriculum. The project design skills and learning aids developed earlier have been found by the writer to be readily applicable in the Junior year as part of the laboratory component in the Machine Design course. Here, open-ended design projects, based upon principal machine design topics, are employed to develop the formative skills needed in the senior design Capstone course. These problems are in addition to textbook (closed-ended) solutions and typically require additional research towards solution. A detailed design report is required and will include a logical analysis, solution, design discussion and summary. The design report components include:

Design Report

- Table of Contents
- Introduction
- Technical Body (sketches, figures, tables, clear statement of design approach, reference all equations).
- Results
- Conclusions and recommendations
- Appendix
- References

The design projects were prepared either on an individual or a group basis, depending upon the topic and relative complexity. Examples of assigned projects follow:

Machine Design Projects

- Failure Prevention: Belt Tightener. Design for a given manufacturing process employing distortion energy theory and reliability.
- Fastenings: Design structural weldment to support a belt conveyor head pulley.
- Antifriction Bearings: Design axle and bearing set for industrial railroad car.
- Gears: Design worm gear and helical gear speed reducers
- Springs: Design leaf springs for front and rear passenger car suspension

- Countershaft Optimization: Minimize diameter and deformation of a pulley system.

It is notable that the students readily participated in the design projects and, overall, developed reports that exhibited a sincere and motivated effort. The student is now ready to address a more comprehensive design project and can entertain the inclusion of a more sophisticated design methodology.

The Capstone Program

An engineering product/project requires more than engineering analysis to be profitable to the manufacturer and desirable to the ultimate user. In order for it to be marketable, it must be user-friendly, functionally aesthetic and be capable of being mass-produced as efficiently as possible. Towards this end, the student will work in a project group, learn to prepare a comprehensive design proposal and final design report, consider alternative design paths, estimate project costs, schedule the critical needs for a project's development and link the project's development with manufacturing processes, ergonomics, codes and standards and safety. The two-semester, typical project sequence follows:

Senior Year: First Semester

1. Retrospective search
2. Development of ideas
3. Development of Proposal
    a. Scheduling/Critical Path
    b. Cost Factors
    c. Alternative designs
    d. Suggested specifications
    e. Prototype requirements
    f. Preliminary report
4. Submission of Initial Design Proposal

Senior Year: Second Semester

1. Proposal returned with comments
2. Re-development of design
3. Re-development of scheduling
4. Prototype completion (if required)
5. Draft of final report
6. Final Design Report
7. Project presentation

A critical juncture of the Capstone project occurs after submission of the Design Proposal to an industrial sponsor or to the instructor who has been supervising the design program. Each design group, upon receiving a professional critique of their Proposal, is requested to carefully review and then further develop their project as deemed necessary. Technical refinements are addressed, careful attention is given to the remaining schedule, a prototype is developed if appropriate, all details are analyzed, the necessary graphics are concluded, and the Final Design is presented to an audience of students, faculty and sponsors. The Final Design report is quite comprehensive and often proves to be an excellent document for future interviews. A brief sample of some Capstone projects follows:

- Workplace Innovation for the Handicapped. Wheelchair was designed that includes a colostomy system and to assist people with lower and upper mobility dysfunctions.
- Solenoid Tester. An electronically controlled solenoid tester was designed for a co-op company to hydraulically pressure test the control valve body solenoids of transmissions.
- Pallet Dispenser. A system was designed for a co-op sponsor to separate pallets, place them on a conveyor and also adjust to different sizes and materials by using a variable frequency drive.
- Diesel Locomotive. A new diesel locomotive was designed for a co-op sponsor to replace the current steam-powered locomotive at a county fairgrounds.
- Water Spray Test Stand. A test stand was designed for a co-op sponsor to test multiple bearings and various bearing types.
- Tailgate Lift System A system was designed to enable the user to lift a load of up to 500 pounds from the ground to the height of the bed of a pick-up truck.
- Physical Therapy Walker. A walker was designed that was geared towards physical therapy associated with the Department of Veteran's Affairs..

Many of the Capstone projects are obtained from our co-op sponsors and other industrial sources. Our co-op program requires that the mechanical engineering technology student be employed in an engineering organization by his/her Senior year. The student will be expected to engage in engineering activities and be supervised by engineers. At this juncture of a student's education, the student will have experienced and participated in several engineering design projects and activities and can be expected to easily partner with the sponsoring co-op organization.

FUTURE PRACTICES

The practice of engineering – and its counterpart engineering technology – is predicted to be exceedingly different in the future than it is now. The writer has recently researched and published articles on the future practices in engineering and engineering technology and finds that we have to address the needs of the industrial sector and provide an academic environment that prepares for expected global technological changes. We will need to consider new engineering technology programs in view of all the current concerns and activity. An extensive survey by the writer has shown that some of the factors that may influence future engineering and engineering technology programs will include the following.

- Prepare for political, social and economic responsibilities
- Have project-centered courses
- Work in multidisciplinary product design teams
- More biology and interest in economics and social sciences
- Engineering faculty should have industrial experience

- Program should be based on industry's needs
- Consider Mechatronics, Bioengineering and Nanotechnology

The traditional forms of undergraduate education must therefore be focused upon practical student educational development to clearly and directly serve the industrial and global environment. We find that many educators, and those principally concerned with the education process, recommend that the following educational components be required to achieve the new industrial and global environment.

- Establish a Freshman Design Experience
- Develop a Continuing Design Program
- Establish an Industrial-Based Capstone Design Effort.

CONCLUSIONS

We seek to improve the quality of engineering technology education by providing an opportunity for the undergraduate to obtain a comprehensive, pre-professional educational experience. To achieve this, we must integrate the combined resources of industry, faculty and academia.

Global trends and changes expected in the twenty-first century will impact upon the need for greater inclusion of engineering technology fundamentals in the undergraduate curriculum. Economic and employment variations will require the technologically-trained worker to have an interdisciplinary understanding and the capability to adapt to continuing changes in employment and assignments. We can effectively meet the needs of student and industry by providing the engineering technology student with a comprehensive design experience that closely matches that encountered by professional design engineers. Those needs must be focused upon practical student educational development to clearly and directly serve the industrial environment.

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