Engineering Technology Program Development for Industry

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ENGINEERING TECHNOLOGY
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In the mid-eighties at Alfred University and in the early nineties at the Indiana Institute of Technology [9], the writer implemented freshmen programs in the curriculum to address the lack of connectivity between the topics in basic science and introductory engineering technology courses. The entering students were exposed to a multi-dimensional course whose basic purpose was to efficiently provide not only an understanding of what is involved in the 'design process' performed in industry but also the *opportunity* to employ and develop those design functions and skills at the very outset of the students' undergraduate experience. The several components of the course were integrated to include:

- Use of technical resources
- Technical report writing and oral delivery
- Research into the functions of technical societies
- Comprehensive discussions of fundamental manufacturing processes followed by design projects that would employ a given process towards the redesign of an existing part.
- Visits to local industries and talks with working technologists.
- Discussions about current and projected technology

These activities were designed to enable the development of a wide variety of open-ended design projects within a group format. Each project provided a creative opportunity for students and required progress reports, oral group activity and a comprehensive, chronological development culminating in a written report with full graphical and bibliographic elements.

We take the approach that design is a creative endeavor, leavened with logic and tempered by experience. Further, it is felt that it is inappropriate to wait until the student has accumulated 'design information' in subsequent (higher level) courses – we can design now! And we proceed with that concept by introducing several comprehensive design projects, organized in group format, developed by specifications, limited in time, but essentially *open-ended.* Now, in order to design, a student needs some basic tools with which to work. We feel that those tools most fundamental to the design process are: the communications skills and the graphical skills. For the former, it is essential to be able to clearly enunciate ideas in both oral and written form. For the latter, it is imperative that one be able to clearly and completely depict an idea *in order that it can be implemented.*

Subsequently, at Eastern Michigan University, the writer developed the *Introduction to Engineering Technology* course [7] which is designed to enable the entering freshmen to fully participate in the activities of an ET via a wide variety of projects that are carefully designed to illustrate the kinds of projects that are serviced by engineering technologists [6]. The activities that ensue serve as a vehicle for motivating students to pursue a clearer understanding of the factors that drive technology. Our initial objective is to make the students particularly aware of the importance of working effectively in a group, because that is the way things are commonly done in the professional world. Some of the things that are discussed include: that it is essential for all group members to establish a harmonious relationship; that it is essential for all group members to provide a reasonably equivalent effort; and that it is essential for all members to seek a common goal, namely, a quality effort within the time period specified. It is urged, that if someone in the group is not providing an equivalent amount of effort, the initial approach would

be to discuss it with that person. If that doesn't work, then the instructor should be notified. We have found this approach to work effectively.
Our next objective is to develop the procedures that effectively implement an open-ended design project. The following procedures are discussed, with accompanying handouts:

- Clearly Define the Effort. Make sure all the requirements are fully and clearly understood
- Identify all the Components. If all sizes and/or specifications are not fully provided, then establish them, with the understanding that they may be subject to change as the project develops.
- Find out About Items that are Not Clearly Understood. Use available sources.
- Develop Several Preliminary Ideas.
- Continue to Refine the Preliminary Ideas. At some early point in the design process, develop a time schedule and a design procedure.
- Consider the Organization of Your Group. It is of value to select a group leader who is sincerely motivated to develop the project to a successful conclusion.
- Develop a Consistent Attitude. Work on the project in a consistent, methodical manner. A project is rarely developed and completed successfully if the activities are erratic and/or marginal.

The project design skills and learning aids developed at the onset of the student's experience can be readily adaptable in subsequent coursework. Further, the formative skills needed for the Capstone design course can be implemented via open-ended design projects introduced to complement the specific topic being covered. It is, of course, exceedingly valuable to the student if the educator has had industrial experience and can provide practical design opportunities based upon those encountered in the professional world [8]. Hence, these design skills and aids are extended throughout the curriculum and are developed, in particular, in the Junior year as part of the laboratory component in the Machine Design course. Here, the formative skills needed for the Capstone Senior Design project are further improved. Open-ended design projects are created to complement the specific mechanical element – or topic – being covered. The purposes of these problems are twofold: (1) to understand, use and become proficient in the 'design process'; and (2) to explore, discover and learn a relatively basic yet significant facet of engineering technology as it is practiced. A detailed design report is required and can include: title; table of contents; introduction; technical body with sketches, figures, tables, chronological development; results; conclusions/recommendations; appendix; and references. Preference may be given to report development on a group basis to continue to learn how to work in an effective and contributory way with other members. 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 goal at this juncture of the educational process is to create a product or process that will satisfy human needs with respect to function, aesthetics, quality and cost. Satisfying this goal will require an understanding of the interrelationship among concept, technical development and marketability; and integration of the technical and aesthetic skills towards development of an engineered product. The Senior Design Capstone Project [5] is an introduction to the methods of

interdisciplinary engineering via participation in a concentrated and accelerated engineering project. It is also a way to bridge the student-engineering professional gap. The objectives and some of the expected benefits of this course include:

- Experience an appreciation of the overall problems in carrying out the open-ended design of a typical complex engineering device or system.
- Enhance their creativity in a practical and dynamic environment.
- Work progressively and positively with others in a practical and scheduled manner.
- An opportunity to use and integrate material learned in earlier courses.
- An opportunity to develop the communication skills required of a professional engineer.
- More enthusiasm for Engineering Technology as a career.

The Mechanical Engineering Technology Capstone Program employs open-ended projects, all of which are developed and designed to benefit the community and, in a cooperative manner, instill leadership among the students that are engaged in this effort. Students are actively engaged in community service by offering their engineering and technological services to design and develop projects for use in both non-profits and small businesses. For example, one student project group offered their engineering services to the Veterans Affairs Hospital in Ann Arbor, Michigan, for assistance in the rehabilitation of wounded veterans. Their project was a Rehabilitation Therapy Walker. The Physical Therapist in the VA Hospital described the project's values and benefits in the magazine 'PT in Motion' [1] in which she wrote that '… when four undergraduate students at Eastern Michigan University approached her about a school project, she knew exactly what she wanted.' Further, '…the students were conscientious and listened well and they'd also listened to their professor who had suggested that they look at the VA Medical Center for projects that could help patients. Knock on some doors and see what you can do, he had advised. And when the opportunity knocked, I answered.'

The very nature of providing an engineering project for a sponsor promotes and develops leadership skills [2]. For example, the client/sponsor may propose a desired 'result' but generally is not familiar with the design stages that must be implemented to arrive at a suitable solution. Here is where the students must take the lead whereby they interact with a variety of sources – consultants, industry representatives and the like – in order to fully develop a satisfactory and cost-effective system. The development – and requirement – for leadership skills was particularly needed for a design project at a County Fairgrounds. Here, a student's father notified his daughter – an MET senior design student – that there was an urgency to replace the current thirty-year old, steam-powered locomotive at the Fairgrounds. The student design team learned that the facility favored a diesel-powered locomotive that would carry fair-goers for years to come. As was expected, the fairground committee had no specific solution in mind, so the students had to take the leadership role and introduce a variety of concepts and designs. The students not only fulfilled the design requirements within the Capstone period, they also built a prototype for display. In conclusion, the scope of leadership efforts included the necessary materials, tools, equipment, accessories and related costs.

The MET student is urged to reach out and work with one another collectively in group projects. The Capstone projects are team projects, providing the valuable opportunity to work progressively and positively with others in a practical and scheduled manner. Due to the fact that the Capstone projects have a client or sponsor, the students will learn to acquire skills for working cooperatively with the promoters of their project. The continuing interactions with

client/sponsor throughout the extended period of project development will promote improvement of those attributes required in a professional setting. The several oral and power point presentations, collectively witnessed by the students' peers, faculty and invited guests, enables a clear assessment of the acquired skills. It is noted that many of the invited guests are the sponsors of the projects being displayed and have the opportunity – and responsibility – to comment on the presentations. Thus, the MET Capstone Program provides the sustainable transition from student to professional by employing real-world project requirements within this program. And the ethical components that are particularly suited for a specific project are fully described in the students' Final Design Report [4].

A significant concluding event that is held each spring at Eastern Michigan University is the Undergraduate Symposium. Here, undergraduate students from all academic departments may be nominated to display their exceptional academic work. Student presentations may be presented in oral or poster format and by single or multiple authors. Recently, a complete energy audit and analysis was performed for the College of Technology at Eastern Michigan University by MET Capstone students. It focused on five key areas to develop solutions to reduce energy consumption and thus save EMU money. The areas investigated were: lighting, HVAC, alternative energy sources, water usage and facilities. Cost-effective solutions were recommended to be implemented for the shortest payback period. Three student groups worked on this: one group developed an audit of the energy usage and determined energy savings and payback periods; another group gathered real-time utility usage that will allow facility managers to correlate performance with occupant load; and the third group designed a small unit that enables the user to monitor the amount of energy being used real-time. This project was displayed in the recent UG Symposium and reviewed by the Provost who was very pleased with the results.

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. We can seek to develop the communication and teaming skills that are an inherent and vital part of design activity and address the need to promote the creative capabilities of the entering student [3].

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