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Enhancing Electrical Engineering Technology Capstone Experience

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AC 2010-451: ENHANCING ELECTRICAL ENGINEERING TECHNOLOGY CAPSTONE SENIOR DESIGN COURSE EXPERIENCE THROUGH INDUSTRY-BASED PROJECTS

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Abstract

The College of Science and Technology (COST) at our university (XXX) offers degrees in Mechanical (MET), Civil (CET) and Electrical Engineering Technology (EET). All the Engineering Technology programs are ABET accredited and have been successful in achieving the TAC2000 outcomes. In particular, our Senior Design capstone course (TEET4010/ 4020) is a comprehensive three-credit, two-semester engineering design course, that all engineering majors are required to take as their capstone experience. We view this course as a very important component in the preparation of a trained EET professional. The course emphasizes both hard and soft skills and serves as an emulation of a real world engineering project. We use both, projects proposed by the faculty and projects contributed from local industry and we partner the teams of student with faculty and industry mentors. As a result of their participation in this course, students are subjected to a real world engineering project development experience for the first time. By participating in real engineering projects, students learn to deal with unplanned events such as: missed deadlines, working in team environment and dealing with difficult team members, even dealing with different industry or faculty mentors. From their participation in the course and the project students get a very valuable learning experience. In this paper, we describe the development of our industry-based projects senior design course. In the next sections we describe the role of the capstone design course in respect to ABET academic outcomes. We also present examples of the type of projects implemented and a summary and listing of future work.

Introduction

The main goal of the engineering capstone course is for the students to apply the theoretical and practical knowledge[1] that they acquire in the EET program for the solution of a real engineering problem. However, although the department has offered this course for many years and students have developed successful and sometimes interesting projects, in its original format, most of the projects developed as part of the capstone course were the traditional ones that were proposed mainly by the students and they did not have any relationship to solving an actual engineering problem.

Background

Since two years ago the EET department started a stronger collaboration with its Industry Advisory Board (IAB) in order to make sure that the EET program fullfills more strongly the ABET outcomes related to:

- Demonstrate that students are able to function on multi-disciplinary teams,
- That students show a strong ability to identify, formulate, and solve engineering problems
- That students are able to understand professional, social, environmental and ethical responsibility.

Due to this collaboration EET faculty and IAB members agreed that the senior design course experience could be greatly enhanced if the students could work in projects related to solve problems that engineering industries face every day. Giving students experience with a real-world design project that involves managing tasks, people, budgets and deadlines. The projects also benefit industry sponsors by providing them with custom-designed engineering solutions, students with more experience after graduation and valuable experimental data and results.

Over the last two years, a new approach to managing the capstone design sequence has been developed. In the previous format, students took the TEET4030 (3-credit, 1-semester) senior design course. The sequence is now divided into two courses: TEET4010 (1-credit, 1-semester) & TEET4020 (2-credit, 1-semester).

The TEET4010 course has four primary objectives.

- To learn the fundamentals of an engineering project management[2] and development such as project research[3].
- To write a project proposal, identify major task involved, task management and scheduling, cost management[4], etc.
- To identify a technical assistance group that will be available as a resource as they implement their project.
- To research all information[5] needed to design and implement their project.

The TEET4020 course has three primary objectives.

- To implement and develop all the hardware and/or software related to their project.
- To write a comprehensive professional project report, with detailed information about the implementation of their project.

- To demonstrate expertise in their project by doing oral presentations and answering questions formulated by peers, EET faculty and industrial partners.

Industry Sponsors

Every year, during our IAB meetings, we ask or industrial partners to provide a list of projects that our students could help them to implement, this list is also enhanced with projects provided by faculty members that are associated to their research. Once the project is approved for development, the industry sponsor only acts as an external technical advisor and does not get involved in the design, implementation or management of the project. The other only involvement is at the end of the senior design course, where he gives an assessment of the development and completion of the project. Sponsor costs are deliberately kept low, for projects requiring additional funding for materials, students will make a proposal to the sponsor. Sponsors have the option of providing additional funding to the team.

Past sponsors have included important companies in our region, such as Gulfstream, Georgia Power and Briggs and Stratton.

Based in this idea, some interesting senior design projects have been proposed that allowed students to develop projects that have provided them with a real engineering experience and have contributed to find the solution to an actual problem faced by our industry partners.

Senior Design Steps Description

From its inception, our department has recognized the value of a capstone design class. The course, as we offered it (to an enrollment of about 20 students per semester), is composed of the following stages:

- The student would identify a group of his peers that are willing to work as a team for their senior project
- The team would identify a project, either research related project suggested by a faculty member or an industry related project suggested by a industry partner
- Each team member would enroll in the Senior Project class and is required to attend weekly project advance meetings
- The team would work independently, with a strong interaction with the faculty advisor and either faculty sponsor or industry partner to complete the project
- A midterm oral presentation meeting, a formal final project presentation meeting, and final project demonstration is required to be delivered with the presence of the entire class, EET faculty and industry sponsors for each project
- A comprehensive final written report describing the project would be submitted.

Having a good support from industry sponsors is fundamental to the success of the senior design course. Our initial strategy has been to approach local companies who are more familiar with our program. We focus primarily on companies within driving distance of the campus so that the students can easily travel to the corporate site (and the industry sponsors can travel to campus). We promote the senior project course to industry in terms of two benefits to the participating company:

- An opportunity to have a group of students specializing in an area of importance to the company
- Having a first look at the graduating class for recruiting. Even if the company is not currently recruiting, they can see a long-term benefit to being involved with their local university
- Having a low cost solution to an engineering problem.

The amount of mentoring that a company provides to the students is entirely up to the company. Some companies like to mentor students very closely, others less so. However, students always have a responsible faculty available for supervision.

This format has increased the level of student achievement in the capstone process and their final project implementation is now typically more professionally manufactured, so that they gain professional experience that could lead to better job or to the development of a commercial product.

Examples of Projects

In the last two years of using this format, we have worked with three Southern Georgia companies. Examples of three projects that show the diversity of the companies, types of projects, and student project results are:

Gulfstream: Gulfstream develops and manufactures small private and commercial aircraft. In particular, Gulfstream had two teams of students working for them. The first team worked in the design of an interconnection box that could be used to connect and test all the measurements devices available in the airplane's cockpit. The students designed the interconnection box and made the design of the printer circuit boards required for the implementation of the system.

The second team of students worked in the design of an intelligent control joystick used to navigate the different cockpit screens of the airplane. The modern airplane control panel has several computer screens that display different types of information available to the pilot.

The intelligent joystick is used by the pilots to navigate the menus and choose the information they want to be displayed.

Briggs Stratton: Briggs Stratton is a well known company that manufactures small gas engines for lawn mowers and small recreational vehicles. For this company, a team of students worked in the design of an Electronic Injection Control Unit to control gas injection to the engines that can be used in any of the vehicles manufactured by this company.

Georgia Power: Georgia Power is the main electric power provider to the region. A team of students developed an alternative energy power source that uses solar and eolic (wind) energy to generate a portable power source. Another team worked in the design of a DC-DC converter that could be used as the basis for an uninterruptible power supply (UPS).

Project Assessment

The projects are evaluated in several stages, in a gradual and continuous way. First students write an initial project proposal that is evaluated for the technical and theoretical information that is required in order for the students to develop their projects. Based on this proposal, students start to develop their initial design; simulations and programming that are related to their projects. Students are also evaluated for team and individual participation. In the middle and end of the semester they do oral presentations that are evaluated by the entire faculty and industry advisors. At the end of the semester they write a comprehensive final report and present the final product to be evaluated according to their completion, technical characteristics, and compliance to the original requirements of the project. In the final report students are required to address any Legal, environmental, ethical or social issues related to their projects and how they solved these issues.

Conclusions

We have described the evolution of the capstone senior design course from individually selected projects to one of industry projects and student teams. The course has continuous supervision and structure to significant mentoring and structure as imposed by a development process. We firmly believe that teaching students both hard and soft skills is important to their survival and success in industry. The abilities to work well with others and manage uncertainties are very important. In future semesters we intend to include more local business and companies to have a wider range of opportunities for the students. We believe that partnering with industry for the senior capstone design course is very beneficial to the students, individual faculty members, college, and industry. We hope that our experiences with developing an industry-based capstone design course will be used by others. We look forward to hearing from others with regards to their experiences.

Bibliography

1. Todd, H. R et al, "A Survey of Capstone Engineering Courses in North America," Journal of Engineering Education, April 1995, pp. 165-174.
2. Porter, J.R., Zoghi, B., Morgan, J.A., "Integrating Project Management into the Capstone Senior Design Course," 2002 American Society of Engineering Education Annual Conference, Montreal, Canada, June 16-19, 2002
3. Morgan, J.A.., Wright, G., Porter, J.R., "Managing Senior Design Projects to Maximize Success: The TAT Team," 2005 American Society of Engineering Education Annual Conference, Portland, Oregon, June 12-15, 2005
4. Project Management Institute, Guide to the Project Management Body of Knowledge, Third Edition, Project Management Institute, ISBN#193069945X, 2004.
5. Dutson, A.J., Todd, R.H., Magleby, S.P., Sorensen, C.D., "A Review of Literature on Teaching Engineering Design Through Project-Oriented Capstone Courses," Journal of Engineering Education, January 1997, pp. 17-28.