A Collaboration of Senior Design Projects with Industry

Duane Swigert
Metropolitan State University of Denver

Abstract

The senior project class is a two semester sequence open to those students who have completed most of their undergraduate coursework in the electrical engineering technology program. Most of the senior design projects in the electrical engineering technology program have been student generated ideas. Occasionally, students have the opportunity to work on a project with an industry sponsor. This paper will describe some of these projects with their benefits and shortcomings. The examples used cover some senior design projects which were approved and completed over a period of years from the fall of 2009 to the spring of 2013.

Senior Design Projects

The two semester sequence, Senior Project I and Senior Project II, are the capstone courses for the Bachelor of Science Electrical Engineering Technology (EET) program at Metropolitan State University of Denver. The prerequisites are such that core EET coursework is completed so that each student has a broad background for idea generation and appropriate tools to implement the project.

During the first semester course, Senior Project I, the students generate their own project ideas and create a proposal for the project. Occasionally, an outside industry sponsor may have a project that they would like to have completed. Once the proposals are accepted, the students finish the semester by working on the details including a list of tasks required for completion of the project, a budget and a timeline for completion. The second semester, Senior Project II, is where the students work on the design and develop a functioning, completed and working project. At the end of each semester, a formal presentation is made to interested faculty, other students, industrial board members and any industry representatives who might be involved with the projects.

The EET department is involved in the approval process for project proposals. The approval is usually given if the project has sufficient breadth and enough complexity to challenge the students. The evaluation also attempts to eliminate a proposal which appears to be too challenging and would therefore have a low probability of a successful completion.

This paper examines various industry sponsored projects developed and implemented from the fall of 2009 until the end of the spring 2013 semester. The projects were selected to highlight some of the successful outcomes as well as some of the lessons to be learned as related to individual and team projects.

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Projects

The projects chosen by the students need to be worthy of being a ‘senior’ design project. This is sometimes the most difficult part of the faculty’s task as they need to be both broad as far as requiring a good representation of the skills and knowledge acquired in the program, and they have to have enough depth to be a challenge to the student or team. Industry sponsored projects come with a mixed bag of good and bad. When a team accepts an industry sponsored project, it may at times make it difficult to separate the bad items away and leave the students with a project. A few of the projects from the last four years highlight the positive and negative aspects of industry collaborative projects.

My involvement with the Senior Projects began in 2009. I started with a Senior Design II class, so their projects were already well underway and being completed. Most of the individuals or teams had projects in which they created the proposal and self-funded their ideas. However, there were three projects in which there was industry involvement. After the first semester, other industry project opportunities became available and were used. Six of these projects are presented and described below with mention of both the positive and negative aspects.

Project Number One

One of the first projects that I became involved with was a team of two seniors working on a design for a robotic unit that was to be part of a larger project. This robotic unit needed to be able to sense tilt angle to assist the robot in driving up an incline. The sensor robotic unit consisted of a single board computer with an Ethernet interface, an accelerometer and a voltage regulator. The complexity was sufficient as well as the breadth of skills required for completion. The company provided all the materials required and was very supportive in working with the team in defining requirements and information. The team had a circuit board fabricated which contained all of the components and software required to meet the requirements at the end of the semester.

The group was very successful in completing this project in the two semester sequence and the sponsor was very pleased with the results. The students exhibited excellent communications and had a very impressive final presentation. For both members, the experience was all that the program could hope for and more. However, neither of the two team members went to work for the sponsoring company as they took career positions elsewhere. Our department was very pleased and proud of the outcome for this group.

Project Number Two

The second project was done by an individual who happened to work with the sponsoring company and was successful in convincing his company to sponsor his project. This project was a special access door on an aircraft which is controlled on the flight deck and allows a camera to be lowered out of the back of the aircraft and used while in flight. The camera can then be re-tracked with enough indications provided so that the aircraft crew would know that all was safely onboard and the aircraft could continue on its mission. This project required interfacing with components which are not presented as part of the department’s curriculum, in particular those items and requirements required within the aircraft industry. However, the student took it upon
himself to learn and understand the requirements and successfully meet all that was imposed by the industry.

Again, this was a very successful project with excellent coordination and cooperation from the sponsor. This type of project would not be possible without the cooperation and participation of a supportive industry partner. The project was completed in the time frame and was successfully used by customers of the sponsor. I do not believe that this project would have been entrusted to anyone other than the individual who was already employed by the company. The individual who worked on this project continued employment after graduation. As before, the department was very pleased with this experience and the successful outcome for both the individual and the company.

Project Number Three

The third project was a mobile relay testing unit that included a Programmable Logic Controller which supplied 1-5 volt and 4-20 milliampere analog signal inputs and digital inputs for 120 volt and 24 volt systems. There was also an interactive programmable touch screen display. This project was designed by a student who worked with the sponsoring company and jointly saw the need for this testing unit. A very complex set of requirements and industry concerns and considerations were required to be met in order to be successfully completed. The individual who worked on this project was able to meet all of the criteria with his design and final completed project.

Yet again, it was very successful and met the needs of our senior project, being both broad and of sufficient complexity as well as meeting the needs of the sponsoring company. I should note that this project would have been very expensive had the individual been required to fund this and it would have been difficult to test and verify operation without the resources available through the industry sponsor. All of the steps were completed in the required time frame. This individual continued his employment with the company after graduation.

Project Number Four

With three outstanding successes, I began to view industry collaboration as a very positive attribute in its own right and became a little less attentive in my scrutiny of what we required as a department. Therefore, when the next opportunity arose for an industry sponsored project, I was not as diligent as I should have been.

At the beginning of a new two semester sequence, a two member team had formed, with one of the members having completed an internship with a firm involved with the space program. When they made their proposal concerning the use of a radiation hardened relay controller for use in an upcoming space program launch vehicle, it seemed like another potentially great opportunity. One of the faculty members who reviewed the proposal raised some concerns about the lack of complexity and vagueness in what was to be completed by the team. These concerns were set aside as our recent experience seemed to indicate that industry involvement was nothing but a win-win situation.

However, as the project team began work, it became apparent that they had selected a very narrow and not sufficiently complex project. Additionally, the timeline was vague for testing...
and completing tasks. Additionally, there was not a good working relationship with all members and the sponsoring organization. Most of the faculty who were aware of the project felt that this was not turning into a good experience but by then, the students were too far along in the two semester sequence to change projects. Attempts were made to try and salvage the project by requiring more from the team but it was a case of too little, too late. For one of the individuals it did lead to an employment opportunity with the firm, but this may have been due to the earlier internship and not directly from the success of the project.

Project Number Five

After that experience, and much discussion amongst the Electrical Engineering Technology faculty, I realized that future industry involvement needed to be more diligently examined before we agreed to the partnership. The next opportunity came from a local company involved with creating Bio-Diesel Fuel created from used cooking oil. Their need was for automating the process as they originally required an individual to monitor and control a number of tasks which took a few hours to complete and had very little required interaction between steps. Paying a worker to turn on a heater, open a valve after a given time, monitor tank levels and either shut off a valve or stop the process was not something the company could really afford in the long term. In some cases, there were minutes between the tasks and in other cases, it would be hours. The whole process, once started, would take the normal part of a working day. The tasks were not complicated, but critical so as to not overflow a tank or destroy a pump if a tank had run dry.

The team took on the task with instructions to look at what was not only required, but to see if additional items could be readily added and to try and look at what was done to increase safety as well for the company. I also tried to emphasize that they should look at creating a system that could be modified as required by the organization as their needs changed.

New problems surfaced with this project. First, the team was not very proactive in contacting the sponsoring company and the individual in the company was a very busy person. Over the two semester courses, a number of weeks would go by with no communication between the team and the firm. This was frustrating for the students as they were trying to complete the project in the time frame of the course. Second, it was not clear that the firm had sufficient funds to help the team acquire and try various options. The school attempted to supply items, but was not always able to supply them in a timely fashion and with what they required. Eventually, the team was able to complete a prototype of what would be required but the end result was less than what they should have been able to accomplish. The final solution did not have the complexity of most senior projects. Neither of the members of the team had employment opportunities with this company.

Project Number Six

The final project to be mentioned was one proposed by an international company with a local presence. They manufacture and either lease or sell floor scrubbing machines in which the operator rides the machine and it washes and waxes large floor areas. The machines have usage related maintenance items which need to be replaced or refurbished after extended use. The company would like a way to monitor usage as well as wear and tear of the machines so that they could help customers ensure less down time for the machines.
This project had a good mix of complexity and breadth. The company had loaned a machine to the team so that they would be able to try various ideas and see what actually happens. A couple of new interesting items have surfaced with this project. Finding a suitable location with access for the students was an issue. Once a location was identified, and the machine was delivered, it was only a short time later that the floor scrubber turned up missing! Apparently, the campus maintenance staff had come across the machine and thought that perhaps they had misplaced one of their units and retrieved it for themselves. Of course this was quickly resolved. Another issue that surfaced was the matter of who was funding the students’ prototyping efforts. Of course the lesson for future industry sponsored projects would be to have a list of possible items which would be agreed upon by all parties before work is started. Most of this seems to be due to a lack of good communication from the student team back to the sponsoring organization. At the time of this writing, this project has not been completed. Indications at this time suggest that this will also be a successful project in which the students have learned and benefited as well as the company sponsor.

Conclusions

Having industry involved with the Senior Project designs has proven to be both beneficial for both the students and the companies. The added dimension of working on a project which may play an important role with the industry partner really brings alive the whole experience and increases the level of professionalism and pride in the final outcome. Of course, there is the added benefit of having a better source of funding and resources available to the students other than what the school may provide.

There are some potential downsides to the cooperated partnership. Obviously, the project needs to allow for a time frame which would fit the two semester window of the students’ schedule. Second, the project needs to meet the criteria of what would be expected of a ‘senior’ project. Finally, there needs to be enough communication between the sponsoring organization and the team so that issues are understood ahead of time and surprises are avoided during the course of the project.

These industry sponsored projects provide an occasion to work on something which would not be possible if it were only a student generated idea. Overall, these have been very beneficial to both the students and the companies involved and will be encouraged for future projects.

Acknowledgements

I would like to thank the Electrical Engineering Technology department and staff for all their efforts in helping to create an environment where our students are encouraged to succeed. In particular, I would like to thank those students and the companies involved with these efforts. I have intentionally left out names so as not to embarrass any individuals or to create ill-will with the companies who had been involved with what has really been a very successful endeavor.

Other Material

Official Course Descriptions

EET 4100 - Senior Project I 1 (0+2)
Prerequisite: Grades of C or better in COM 2610; EET 3120; and EET 4370, satisfaction of Level I and Level II General Studies requirements with a cumulative GPA of 2.0, and senior standing.

This course requires the planning and designing of a project in consultation with faculty advisors and industry contacts. (Senior Experience)

**EET 4110 - Senior Project II 2 (0+4)**

Prerequisite: SPE 1010, EET 4100, and EET 4340 with grades of “C” or better.

In this course, the student completes the project he or she started in EET 4100. The project is built, tested, and demonstrated. Written technical reports and oral presentations on the project are required. Part of this course involves the student working with a faculty member who acts as a consultant. (Senior Experience)

**BIOGRAPHICAL INFORMATION**

DUANE SWIGERT – Assistant Professor in the Department of Engineering Technology at Metropolitan State University, Denver, Colorado. Previously, he held the position of Member of Technical Staff with AT&T Bell Laboratories, Lucent Technologies and Avaya.