Successfully Partnering with Industry through the Industrial Engineering Senior Design Project

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Abstract

This paper describes a model for successfully partnering with industry through the Industrial Engineering Senior Design Project. It describes the model for the senior design project at the University of Pittsburgh, the instructor's role, how projects are assessed, how projects are solicited, how projects are selected, how project teams are formed, and benefits to the department, faculty, students and industrial sponsors.

Introduction

It has been shown that industry experience is a proven benefit in the education and learning process of engineering students. The Industrial Engineering Department at the University of Pittsburgh has had a long history of utilizing team-based senior design projects working with a company on a significant problem during the final semester of the students' senior year. Over the last decade, the senior design class faculty have made a concerted effort to enhance the senior design experience by improving the process by which projects are selected, monitored, and administered. In the Fall 2001, the department launched its **S**ponsor **A**n **I**ndustrial E**N**gineering **T**eam (***SAINT***) Program. Via this formalized program, the faculty and students work more closely with their industry sponsors, requiring a greater commitment on the part of the industry sponsors to support the project throughout its life cycle. Furthermore, the industry sponsors are now charged a fee for a student team. This has raised the sponsor's expectations and students are charged with bringing their project to a successful completion. Our experience has been that this new program has been a win-win situation for all. For example, students get more challenging projects, industry sponsors get good solutions to their problems that can save them money, and faculty develop long-term relationships with the companies leading to future collaboration in the form of research projects. This paper describes the model being used at the University of Pittsburgh and its benefits. This approach or elements of it can be easily adapted into an existing senior design capstone course.

Model

Students in the Industrial Engineering Department at the University of Pittsburgh work in a team of three or four students and utilize analytical investigation techniques to solve a significant problem at a client site utilizing industrial engineering capabilities acquired during their program study. The course provides a good learning experience for students whereby they gain project team experience, write a formal technical report, and professionally present their findings. The

course is meant to be a capstone and taken during the student's final semester. The department has toyed with the idea of having the senior design project span two consecutive semesters, but with our strong participation in our Cooperative Education Program (approximately 70%), this approach would not be practical.

The course is tied closely with the ABET criteria which states that students must be prepared for engineering practice through the curriculum culminating in a major design experience based on knowledge and skills acquired in earlier coursework and incorporating engineering standards and realistic constraints that include most of the following considerations: economic, sustainability, ethical, social, environmental, manufacturability, health and safety, and political. Students are asked to address and document (as appropriate) these factors in their final project report.

Project groups meet with the course instructor weekly throughout the semester. Although one faculty member is in charge of the course, project teams are strongly encouraged to consult with other faculty members in their areas of expertise. The purpose of the weekly meetings is for the students to present their status on the project (what they have accomplished, what remains to be done, are they on schedule, ahead or behind, etc.), alert the instructor as to any potential problems or challenges facing the team, and to review the technical merit of the in-progress work that is being accomplished. To kick-off the meeting the instructor reviews a weekly status report memo that is prepared by the students covering the aforementioned topics. This memo also serves to document the week-by-week progress of the team.

Throughout the semester there are regular, periodic milestones designed to keep the project on track. These are discussed next.

Week One. During the first week of the class the instructor forms the teams and assigns the projects. Details of these processes are discussed in latter sections of the paper.

Week Two. Students are expected to make contact with their project sponsor organization and schedule a visit to their facility in the second week of the semester. Typically this visit will entail a meeting to cover introductions, gain further explanation about the project, etc., and a plant tour.

Week Four. During the fourth week of the semester, the students submit a project proposal broadly describing their problem and speculating on probable methods of analysis. The project proposal contains a brief company background, problem statement, probable method of analysis, deliverables, a Gantt chart detailing all major steps in the project, and a linear responsibility chart. The project proposal is also presented orally to the entire senior project class and interested members of the Industrial Engineering faculty. Furthermore, the instructor and project sponsor must approve (in writing) the project proposal. The project proposal is really akin to a statement of work and is meant to be somewhat of a "contract" for the project, setting future expectations. The project proposal can be very important at latter stages in the project when it is not uncommon for the project sponsor to try to expand the scope of work (project creep). In addition, the project proposal helps to make sure that the team is taking a systems approach to the project and has a solid plan.

Week Ten. Each project team gives a presentation to the entire senior project class and interested Industrial Engineering faculty regarding the current status of their project during the tenth week of the semester. The presentation should detail what has been done and what remains to be done. Current Gantt charts are also reviewed. The purpose of this meeting is to make sure that the students are on the right track, while they still have time to correct any problems.

Week Fourteen. In week fourteen, students submit a draft of their final project report to the instructor. The instructor reviews this report and provides feedback. The purpose of this step is to improve the quality of the final report that is given to the project sponsor.

Week Fifteen. The project comes to a close in week fifteen. Final project reports are due and the final presentation is given to the senior project class, first-term seniors (even a few juniors attend), Industrial Engineering faculty, and project sponsors. The students will even invite family and friends to attend. The presentations are preceded by a poster session in which each team prepares and then displays their poster to overview their project. The posters are later mounted on the walls throughout the Industrial Engineering Department and serve as an excellent recruiting device for prospective students.

Instructor's Role

The instructor's role in this course is primarily as a mentor and a facilitator. The instructor ensures that the project proposal is appropriate in scope and content, the approach is sound and achievable, and that the project is carried out so that it results in a valuable experience for the student team and the project sponsor. The students are expected to contact other faculty members in the department depending on the technical scope of their project.

Project Assessment

Projects are assessed throughout the semester. In addition, there are numerous checks-and-balances throughout the semester designed to ensure a successful completion of each project and ultimately a satisfied project sponsor. As the students are reminded at the beginning of the semester, their work is a reflection of the University of Pittsburgh, the Department of Industrial Engineering, and ultimately the instructor (as many of the projects result from personal contacts made by the instructor). Failure is not an option! Furthermore, it is the instructor's hope that all projects will be successful and all students will receive a letter grade of "A" for "superior attainment." The actual breakdown of grading for the project is outlined in Table 1.

Project Solicitation

During the summer months prior to the ***SAINT*** Program being launched in the Fall 2001 the Industrial Engineering faculty prepared a brochure explaining the new program in an effort to solicit high quality projects. This brochure was distributed to project sponsors from the last five years along with a letter explaining the program and the changes in the new program from our existing senior project course. One of the major changes was that project sponsors would now be charged a "fee" for a student team (prior to this point in time, projects were done for free). This "fee" amounted to the project sponsor making a donation of $3000-$5000 to the Industrial

Engineering Development Fund at the completion of the project. The brochure explained that this money would be used to improve the infrastructure of the department. One specific use of the money would be to upgrade the facilities used by the senior project teams (more will be said about this later on in the benefits section of the paper). This may not sound like a lot of money, but mentally speaking if a company is "paying" for something, then they take more notice (which is actually good). We were concerned that some of the companies with whom we had worked before would balk about this new fee (and a handful did). Overwhelmingly, however, what we found was that the companies were willing to pay for the projects.

The instructor tries only to solicit the number of projects that are actually needed. Occasionally when more projects are obtained than needed, companies are disappointed when they cannot get a team of students. On the negative side, this situation could discourage companies from participating in the ***SAINT*** Program. On the positive side, if there are more projects than teams, then companies may try to make their project "better" by making it more interesting, providing more resources for the students, etc.

Table 1. Grading policy.

Percentage	Item
10%	**Project Management** – regularity of meeting with the instructor, use of outside resources, making regular progress, proper use of project management tools, working as a high-performance team
10%	**Quality of Presentation** – professionally prepared and delivered, visuals are easy to read, well-rehearsed, clear, organized
20%	**Quality of Report** – adheres to requirements, well-written, easy to follow, organized, complete, attractive
10%	**Quality of Poster** – tells a story, complete, good use of colors
40%	**Quality of Project** – use of a systems approach, project approach and methodology is sound, problem was solved, solution fits the company, economic analysis was performed
10%	**Client Satisfaction** – assess the students on the following issues: professionalism, knowledge and skills, ability to work without close direct supervision, creativity, ability to come up with a solution to address their needs, ability to work in a team environment, demonstration of a strong work ethic

Project Selection

Companies wishing to participate in the ***SAINT*** Program submit a memo to the instructor outlining their project. In addition, they identify a company contact person. The instructor works with the company to ensure that the project description is clear and appropriate. Typically the project sponsor outlines a project that is too aggressive to be completed in one semester. The instructor helps to narrow the focus to something that is achievable within the semester. The instructor also pushes that the contact person will be someone who is at a high enough level within the company to be able to open the right doors for the project team, yet at a low enough level so that this person can actually work with the team on a weekly basis and serve as a mentor

for the team. It is best (although not absolutely necessary) if the contact person has an industrial engineering degree because this person can most easily relate to the team.

Ultimately the instructor will seek to select "good" projects, or those projects that are challenging (yet doable), encompassing (or those that result in the student pulling together multiple skills that they have learned throughout their industrial engineering education), and interesting. The instructor will also try to gage the commitment of the company by their willingness to sponsor the project (make the $3000-$5000 donation) and commit the necessary resources to the project (most notably the company contact person). Ultimately, the instructor will also consider the long-term relationships that can be formed with the company and the Department of Industrial Engineering.

Formation of Project Teams

Of foremost concern to the students is being assigned to a "good" project team. By "good" students mean that they want to work with students they like (their friends), who are smart, and who will carry their load. From an instructor's perspective, he/she also wants to put together "good" project teams. However, by "good" he/she means teams that can successfully carry out the project (with minimal conflict.) Forming teams will thus require the instructor to consider each student's capability, prior experience, likes, and dislikes.

Prior to the first class meeting, students are sent a short synopsis of each of the projects, a class roster, and a survey form (Student Bio Sheet) so that the instructor can learn more about the student and their interests. The project synopsis contains the company name, location, and a paragraph description of the project. The Student Bio Sheet asks the student to list:

- Names of up to three other students with whom they wish to work with;
- Name of at most one student with whom they would have a conflict working with;
- Technical electives that they have taken or are currently taking;
- Work experience (cooperative education and summer internships); and
- Statement of which project(s) sounds the most interesting to them and why.

Information listed on the Student Bio Sheet is kept in confidence and only viewed by the instructor. The instructor also obtains each student's overall grade point average in an effort to balance the student resources across the projects.

Next comes the task of forming the teams. Two observations can be made: (1) there is no magic formula and (2) there is never an "optimal" solution in which all desires can be met. However, the good news is that despite these constraints, "good" project teams have been able to be formed.

Benefits

The ***SAINT*** Program has resulted in numerous benefits to all stakeholders including the department, faculty, students, and industrial sponsors. Figure 1 depicts a conceptual model of increased interaction between industry and various levels within the Industrial Engineering

Department. The Department of Industrial Engineering benefits from the ***SAINT*** Program in that it can generate money for the department. In the case of the Industrial Engineering Department at the University of Pittsburgh, our goal is to bring in about $40,000 to our development fund each year as a result of the ***SAINT*** Program. This allows the department to improve its infrastructure when it did not otherwise have the resources. For example, in the Fall 2001, the department dedicated "Design Studio A," fondly renamed to "DSA" by the students. This room is a dedicated resource for the senior project teams. It contains a work area, white board, computers, printers, and state of the art software. Students have remarked about their satisfaction with this new resource and have said they do not know what they would do without it.

Faculty. Faculty benefit from the ***SAINT*** Program through the relationships developed during the projects. For example, research projects working with faculty and graduate students, and consulting engagements have been just a few of the benefits that faculty have realized from the ***SAINT*** Program.

Students. Students benefit from the ***SAINT*** Program. In addition to the improvements in the infrastructure in the department that has directly benefited the students, the Department of Industrial Engineering has found that by charging the project sponsors a "fee" to complete the project that the company puts more resources onto the project. This results in a more challenging and meaningful project experience for the students. The companies also raise the bar with higher expectations for the projects and from the students. This leads to a great learning experience for the students.

Industrial Sponsors. There are numerous benefits to the industrial sponsors:

- Additional resources to their team (student as well as faculty time);
- A fresh and unbiased perspective;
- A great pre-recruitment tool;
- Significant savings such as cost savings, inventory reductions, quality improvements, improved productivity, and reduced throughput time; and
- Development of collaborative relationships with the Industrial Engineering Department.

The strongest evidence of the benefits to the sponsors is the fact that they keep returning to sponsor more projects.

Summary and Conclusions

This paper describes a model for successfully partnering with industry through the Industrial Engineering Senior Design Project. It describes the model for the senior design project at the University of Pittsburgh, the instructor's role, how projects are assessed, how projects are solicited, how projects are selected, how project teams are formed, and benefits to the department, faculty, students and industrial sponsors. The model is easily portable to an existing senior design capstone course and represents a win-win situation for all stakeholders.

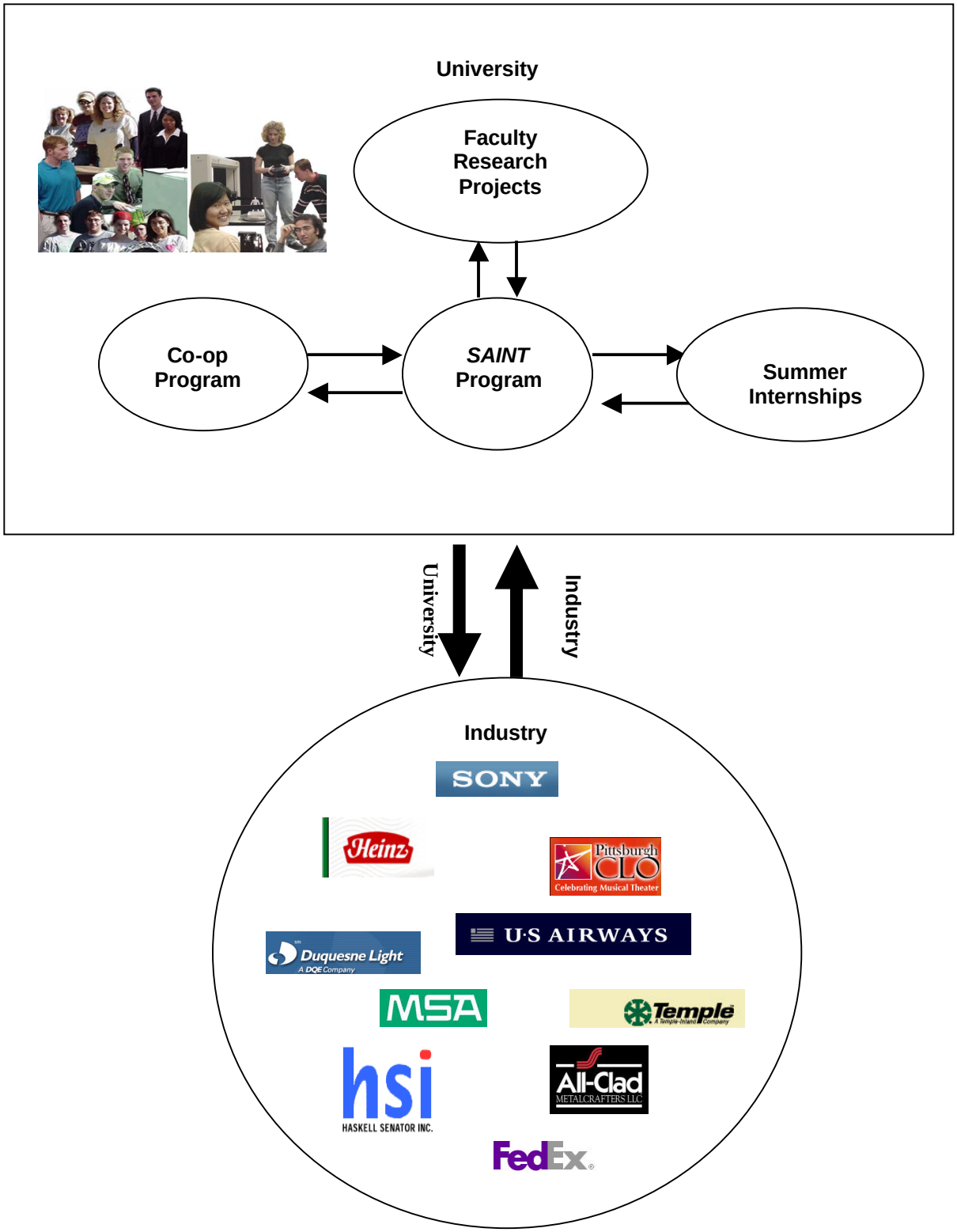

Figure 1. Conceptual model of increased interaction resulting from the ***SAINT*** Program

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