

Tying Industry to Engineering Education: A Case Study on Developing an Academia/Industry Relationship with an Emphasis on Benefits Accrued and Lessons Learned

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Abstract – During 2004, three Industrial Engineering faculty members from Mercer University developed a close relationship with a local manufacturing company. This relationship evolved into three primary outcomes. The first outcome was obtaining projects at the plant for our senior capstone courses that provided real world experience. The second outcome was obtaining summer jobs for two of the faculty so to maintain currency in their respective fields, and a summer intern position for a rising Industrial Engineering senior. The third outcome was the development of case studies from the plant to be used as educational tools. As with any truly worthwhile relationship, the building process was an experience involving both gratification and disappointment, both of which provided valuable learning experiences for the faculty team. This paper discusses how the relationship was formed, why the relationship was formed, the successes, failures, and lessons learned and where we go from here.

Keywords: Industry partner, capstone design

INTRODUCTION

The mission of the Mercer University School of Engineering is to “educate a student who is prepared to be a practicing engineer, one who can responsibly contribute to a global society that is becoming ever more dependent on technology.” There are several ways by which an engineering student may become prepared for practice, including co-op experience, internship, and industry-based design projects. For the most part, these experiences involve a relationship that is primarily between the student and the industrial partner. Although the school or university may have a strong relationship with industrial partners, and individual faculty members may work with local industry, there is usually not a direct link connecting faculty, industry, and undergraduate students. Establishing such a link would not only strengthen the educational benefit of individual projects for the student, but can also allow the faculty member and industrial partner a unique opportunity to develop a mutually beneficial relationship.

The literature also supports the educational benefit of establishing a link to industry. One such reference finds that it is becoming increasingly clear that industry is an important customer of engineering education, and that engineering educators can better meet the needs of this customer through course-based industrial projects [Todd, 7]. Surveys of employers suggest several areas in which we can better prepare our students for the world of work [Society of Manufacturing Engineers, 6; Todd, 7]. In fact, feedback from industry leaders helped shape the revision of intended educational outcomes known as EC2000 [American Society for Engineering Education, 1; Dutson, 2]. Many schools have reported on the benefits to students who participate in real-world project-oriented senior capstone design courses. It has been noted that there are benefits to faculty as well [Gorman, 3; McKinnis, 4; Todd, 7]. Although the literature shows that industrially based projects benefit students, faculty and the industrial partner, there are costs as well. Costs may be financial, in terms of money charged to the client for student participation [Dutson, 2]. Costs in terms of time and effort have also been recognized. Students may express

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concern that real world projects take more time to complete and that working in teams is frustrating [Dutson, 2; Tonso, 8]; faculty observe that these projects consume more time to organize and monitor [Moor, 5].

To assess this idea of a close relationship with industry, during 2004, three Industrial Engineering (IE) faculty members from Mercer University partnered with a local manufacturing company. The faculty members' objectives in developing this relationship were to develop learning opportunities for students, to provide faculty and students with opportunities to develop and maintain technical currency in their respective fields, and to identify potential research opportunities. The first objective was met through the development of real world projects at the plant for three of our upper-level courses. The second objective was met through summer jobs for two of the faculty, and a summer intern position for a rising IE Senior. The third objective was met through the development of case studies from the plant to be used as educational tools. As with any truly worthwhile relationship, the building process was an experience involving both gratification and disappointment, both of which provided valuable learning experiences for the faculty team. This paper explores why and how the relationship was formed, the outcomes of the relationship, and lessons learned.

FORMATIVE STAGE

In this section, we discuss why we pursued an industrial relationship, how we went about pursuing the relationship, and why the reciprocating company perceived value in the relationship.

Why a Relationship Was Pursued by the Faculty

The introduction above cites literature describing why academic / industrial relationships are important. In addition, the authors personally pursued the relationship for the following reasons:

- Potential work experience for faculty to remain “current” – we believe an excellent means for Industrial Engineering instructors to continually educate themselves with current industry practice is to simply to seek out work in industry.
- Desire to obtain real world capstone projects – we believe students should be exposed to real world projects. While there is a place for “sanitized” case studies, the “messiness” of real world projects is also a valuable learning experience.
- Obtain raw material for research – building industrial relationships is a wonderful source of ideas for obtaining material and incubating ideas for new lines of research.
- Open doors for student as interns or future employees – building relationships with industry will also open doors for students as interns and future employees. We believe a vital component of a student's education is summer intern or co-op experiences.

How It Was Pursued

There are many ways to pursue a relationship between academia and industry. We describe our approach just to provide an example of what worked for us.

Mercer's School of Engineering employs an Industry Liaison, Mr. Ray Crumbley, who has developed contacts with various industrial companies throughout Georgia. Ray has several goals when he meets with industry including soliciting Senior Design projects, promoting the co-op and summer intern program, and simply raising the general awareness of the School of Engineering within the business community.

Ray has contacted numerous regional companies with varying results. His general observation is that developing a relationship with industry is a very “hit or miss proposition” based primarily on the person contacted at the industrial facility. Occasionally Ray will come across an individual that understands the value and is eager to develop a relationship with the University. Ray found such a person who was the plant manager at a local manufacturing facility. When Ray finds these types of individuals, he will often communicate that to faculty that most closely relate to that company's needs; in this case the person contacted was Dr. Scott Schultz from Industrial Engineering.

Scott arranged several visits with the plant manager to discuss how the plant and the school might work together. The primary ideas discussed included access to intern students, ideas for capstone and Senior Design projects, and potential consulting.

At the same time, Dr. Joan Burtner had also begun establishing a relationship with the plant manager through the local American Society for Quality (ASQ). After the plant manager made a presentation on lean manufacturing at one of the monthly ASQ meetings, he suggested that he would like to help share the lean philosophy with students at Mercer. Subsequent discussions also revolved around short-term course projects, positions for co-op students, and potential senior design projects.

As the relationship grew a third faculty member, Dr. Laura Moody, was introduced. Laura's interest was in obtaining real world case studies for the Industrial Engineering Capstone course.

Benefits Perceived by Industry

The industrial partner in this case was particularly interested in forming a relationship. This of course begs the question of "why the interest?". What benefits does the industrial partner hope to obtain? Our perception, as faculty, is that there were a number of benefits that the industrial partner was hoping to obtain.

First, access to students for summer intern and co-op positions is one of the primary benefits that an industrial partner can receive, and our industrial client expressed a clear desire to see our students "in action" solving real problems for the plant. In addition, our partner expressed the belief that supporting student projects helped to fulfill the corporation's need to provide community service. Finally, direct access to faculty offered several benefits for our partner, including informal discussions leading to new ideas for the business to try out, access to consulting services, and ongoing student projects that directly benefit the company's bottom line (although our partner, like all clients in such situations, must accept that student projects may be more of a learning experience for the students than a direct benefit to the business.)

There were also pitfalls observed by our partner that reflected the experience of other industry clients. These mainly relate to student performance, but also describe faculty issues. These complaints include a desire for complicated high tech solutions, narrow view of engineering and related disciplines, weak communication skills, little skill working in teams, and no knowledge of value engineering [Todd, 7].

OUTCOMES

In this section we describe the outcomes of the academia/industry relationship. We first describe the primary objective / outcome of obtaining real-world course-based projects. Next we describe how the relationship resulted in summer jobs for both faculty and students. We then describe the final and most lasting outcome of acquiring material for the development of educational case studies.

Projects for Upper-Level Industrial Courses

During the Spring 2004 semester, three student projects were established with the industrial partner. In this section we provide a brief description of each project. In a subsequent section, we discuss lessons learned from these projects, and how we might approach similar projects differently in the future.

Students in the Industrial Engineering program take a required senior level course entitled Industrial Engineering Capstone Design. In this course, students engage in two short, focused team projects for internal and external clients. These teams are essentially "self-selected", with the instructor reviewing the individual credentials of each team member to ensure some level of capability between team members and their project of interest. One such project involved developing a process mapping for the local manufacturing company. The project lasted approximately 6 weeks, and required the student team to observe and map a portion of the manufacturing process in support of the plant's lean initiative. The team, which consisted of three students, enjoyed full access to the manufacturing floor, and were guided by an experienced member of the manufacturing team who provided them with invaluable insights into the process, as well as the goals and constraints of the lean initiative they were supporting. The results of this successful project were shared with the manager of the plant, who provided feedback regarding the assumptions, analysis, and conclusions drawn by the team.

In addition students in the Industrial Engineering program take a required junior level course entitled Modeling and Simulation. In this course, students are required to use the ARENA simulation modeling environment to model and analyze a real-world situation. The students are told to form into teams and to find a real-world process to model. One group of students chose to model a new finishing line for the industrial partner. The project included gathering information about the process such as cycle times, floor layout, number of workstation, anticipated volumes, etc... Unfortunately, the combination of a student team that lacked initiative and a project of very low importance to the industrial partner, resulted in a very mediocre project. This particular team may have lacked initiative because they were a group of students that were placed together by the instructor when they had not found a team of their own.

The final project was for the Industrial Management Case Studies course taken by seniors in the Industrial Management program. In this course, students are presented with various case studies that are designed to help them learn to synthesize knowledge from various components of their curriculum (manufacturing, operations research, total quality, economics, accounting, management, and statistics). All of the case studies are based on data from actual companies (Lucent, NASA, Cedarworks, Chick-fil-A, etc). One such case study was based on a need identified by our local industrial partner. A team of six students (in this case the entire class) was sent to the facility to develop a cell configuration for a new style of product that was scheduled to go into production within the next six weeks. The "physical simulation" project was scoped and developed by the plant manager who had used this technique successfully in the past. The physical simulation concept requires the team to develop the order of operations, identify the equipment needed, arrange the placement of the equipment, determine the number of workers needed, and estimate throughput.

Summer Jobs Opportunities for Faculty and Student

As a result of the relationship established, two faculty members and one student were given an opportunity to work at the local manufacturing facility during the summer months. Joan Burtner worked part-time as a quality engineer. Overall, it was an excellent experience in which she was able to 1) establish benchmarks for quality and productivity within the assembly, finish, and packing areas; 2) document quality activities, write reports, and make recommendations for new directions in the quality program; 3) represent quality engineering on a cross-functional team organized to improve the repair operation; and 4) help organize efforts to restructure the facility into a Lean Enterprise.

Scott Schultz was also given an opportunity to work part-time during the summer. Scott readily accepted the position. He believed that getting back into a manufacturing environment again would help refresh his IE skills and give him an opportunity to practice areas in which he taught, such as process improvements. In addition, getting "hands dirty" would and did generate ideas for future research and student projects.

This academic/industrial relationship also opened the doors for a Junior IE student who accepted a full-time summer intern position at the manufacturing plant. In addition to making a little money, this student was given numerous assignments and was provided with significant freedom on ways to help the plant. The student made a very favorable impression on the plant and gained significant experience.

Obtaining Material for the Development of Case Studies

The third primary outcome of the relationship was the acquisition of data, material, and the experience necessary for the development of instructional case studies. Two such case studies were developed: a process improvement study and a quality system development study.

Process improvement case study – through the course of the summer employment, Scott Schultz performed a process improvement study. Scott was asked to study an assembly process which was not obtaining the desired throughput. Several days worth of data were collected for the process, recommendations were made to management, and an action plan was adopted. This project was captured in the form of a case study. The case study is presented describing the process, the method of data collection, the problems encountered while performing the study, and the actual data that was collected. Students are then asked to suggest ways to improve the process with supporting arguments.

Quality tracking system – During the same summer, Joan Burtner spent six weeks documenting relevant processes, conducting time studies, and building an electronic data base for current defect data for the repair operation. As a

result of those efforts, she requested that the plant manager assign a cross-functional team to address problems in the repair operation. The team developed a new tracking system for defective items in need of repair. The system was implemented in mid-summer. By the end of the summer, the system was fully operational and deemed successful by the Repair Operation supervisor and the plant manager. At the end of the summer, Joan developed a case study describing the development and implementation of the quality tracking system.

Lessons Learned

As with any truly worthwhile relationship, the building process was an experience involving both gratification and disappointment, both of which provided valuable learning experiences for the faculty team. In this section we describe our lessons learned.

Emphasize that students act professionally at all times - Do not underestimate the need to remind students to act professionally at all times. Stress to the students that they are representing their University and that both their positive and negative actions will be magnified and noted. Stress that students be prompt to meetings, be attentive, dress appropriately, etc... Again, keep in mind that some students may just be going through the motions; others may not be taking the project as serious as they should, while others will dive right into the project. This became very apparent when we received immediate feedback from the industrial partner that for one our teams, some members were not punctual to meetings and had somewhat of a detached attitude towards the project. Many industrial partners may be able to forgive a lack of knowledge and experience, but may find it difficult to overlook attitudes which are not professional.

Size and formation of student team – Size does matter. Student teams that meet with industrial partners should be relatively small. We suggest 2 to 4 person teams. Larger teams tend to be more unwieldy, and harder to manage. Keep in mind what most educators know, that some students are more interested in passing than learning. Smaller group sizes tend to force all members to be active participants. We can provide anecdotal evidence from our own experiences that both the students and the industrial partner are more satisfied with the results and experiences of a smaller team. One area where we have little experience is on how teams are formed. Most of our team projects tend to be self-selecting teams. An area we plan to assess in the future is the performance of teams formed by the instructor versus those teams that are self selected. One final comment on teams is that proper orientation of the team is a vital component of success. This may be the students' first exposure to industry. Provide an orientation which stresses the professionalism mentioned above, sets the expectations of the projects, possibly contains a safety discussion, and also discusses the importance of leaving a good impression.

Setting expectations – One vitally important aspect of developing a student project is properly setting expectations with the industrial partner. For example, when an instructor assigns a 6-week project, they assume a student will spend somewhere from 4-8 hours a week on the project, with the bulk of the effort occurring a few days before the due date. The industrial partner may assume 6-weeks as maybe 20 hours a week and a consistent level of effort.

Project scope – Some authors suggest that the project should be important to client even though it is not critical. The important issue is that the project scope be well defined so that it can be accomplished well within the time constraints of the school and the employer.

Clearly defined objectives and explicit instructions – A short term student project should be clearly defined. The industrial partner must remember that the students are entering an environment in which they are unfamiliar. They only know their immediate contacts at the facility, and do not know the numerous company policy and procedures which employees take for granted. Therefore, the projects need to be clearly defined, and explicit instructions given for obtaining information and data.

Don't overwhelm the industrial partner – Don't assume your industrial partner knows when to say "enough is enough". We had several simultaneous projects going on with this particular partner. The industrial partner welcomed and encouraged all the projects, but when it came time for execution, the industrial partner may have been stretched a little too thin. All the contacts went through the plant manager and that with two or three groups calling on the plant all in roughly the same month, it probably seemed overwhelming. In retrospect, with the plant manager preferring to be the primary contact, we should have scheduled the projects such that only one project was occurring during any given month.

On the other hand, had the plant manager delegated the role for the primary contact, the time impact of multiple projects would not have been as significant.

Risks in doing live projects versus case studies – there are numerous risks in doing live projects. Real projects tend to be “messy”. Some industrial employees may be hostile to the projects being undertaken; priorities at the company may not be in line with the students needs and requests for information may go unheeded; too little, too much, or misleading data may be available; etc... While these and other unforeseen situations will arise and may be uncomfortable for both student and instructor, the instructor can use these occasions to provide students a “teachable moment”. These situations will bring an added realism to the projects.

Active participation by instructor – when beginning a project with the partner, clearly define the expected level of participation by the instructor. In some cases, the industrial partner may want the instructor to guide the overall project effort. At other times, the partner may want the instructor to be absent so to see how well the students can work on their own.

Don't put all your eggs in one basket - One lesson that became painfully clear is to be careful not to place all your emphasis on a single relationship. No matter how much effort is expended or how well the relationship is handled, situations beyond one's control can arise to terminate a relationship. In the case with our relationship, the local manufacturing company was closed by corporate headquarters, which cited a decrease in demand for the plant's products as cause for no longer keeping the plant in operation. Thus all our efforts to foment a relationship were terminated.

SUMMARY AND CONCLUSIONS

Establishing the relationship with our industrial partner was challenging, rewarding, and at times disappointing. We obtained rewarding experiences with summer employment for faculty and students, rewarding experiences in gaining valuable data for case studies, and both rewarding and disappointing experience with our student projects.

The lessons learned from this experience were invaluable, and the faculty involved will continue to aggressively pursue additional industrial relationships.

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Dr. Laura Moody

Dr. Moody is an associate professor of Industrial Engineering in the Mechanical and Industrial Engineering department at Mercer University. Dr. Moody taught for 12 years in Mercer's School of Engineering before leaving Mercer to spend 3 years as the manager of the North American Usability Group for Whirlpool Corporation. At Mercer, she's taught a variety of courses at the graduate and undergraduate levels and was for two years the chair of the Department of Industrial and Systems Engineering. At Whirlpool, in addition to managing the usability group and conducting user research, she participated in a variety of global innovation efforts and worked with colleagues in a variety of fields in the US, Europe, Latin America, and Asia to promote customer-centered design. Her primary research and teaching interests are in ergonomics and human-machine systems design.

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