The Community Based Capstone Design Experience: More than Meets the Eye

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Abstract
For the past 36 years, Bradley University’s Industrial Engineering program has used community-based projects as the basis for the Capstone Design experience. For the past 25 years, the “clients” for these projects have been asked to pay for the service provided. The course emphasizes real-world team problem solving and the need for strong written and oral communication skills. Such a course prepares the students to work in industry following graduation and also provides the industries involved with excellent solutions to some of their problems. This paper presents many of the secondary benefits that go beyond the immediate impact on the students, the client and the department.

Background
Since 1967, Bradley’s Industrial Engineering program has completed more than 250 capstone design projects for more than 100 area and regional clients. In all cases, the primary objective has been (1) to provide the students with a high quality professional educational experience and (2) to help the client solve a significant problem. Our experience has been that meeting the second objective also fulfills the first objective.1

The format for the capstone design course is a one-semester, 3 or 4 people per team project. The problems are all obtained from and funded by local and regional industries. Being able to convince industry to pay for the project is the result of establishing a record of many years of providing quality solutions to significant industry problems. Having all projects funded is a critical consideration as the quality of the problem and the expected return significantly increases when industry is paying for the project.

Each project team is assisted by an internal steering committee of 2-5 key individuals from the client’s organization and a faculty team of 2-4 members. The faculty team is the same for each project, an element that insures consistently higher quality results. This also tends to result in the team solving the “real” problem rather than trying to make the problem a quality problem or a facility layout problem or an ergonomics problem. For a complete discussion of the organization and management of the project course together with the impact on industry, see Emanuel (2001).

Two communication experts also support the student team. The written communication expert teaches the Technical Writing class taken currently with the design course by all project team members and an oral communication expert who has over 12 years of experience working with past departmental design teams. For a complete presentation of the integration of communication skills into the design course, see Emanuel, Kerns and Kumpf (2002).
Benefits
The benefits of the project recommendations to local industry include the following examples.

1. The design of a production scheduling system that reduced the order filling time from an average of 3 weeks to 3 days. Estimated savings included the $1.5 million allocated for a planned building expansion that was not needed as a result of the project.

2. A plan for changing the way a company creates, prints and stores their technical documents that could save the company $2 million a year.

3. A plan for plant consolidation that could save $3 million per year over what the company had planned.

4. A five-year plan for company expansion that will increase the company’s potential income from $38 million to over $50 million.

Projects of this type have a tremendous impact on the students that are involved as well as on the industrial client. The experience and resulting confidence the students gain prepares them for a smooth transition into industry and makes them valued employees. Although the educational objectives for the capstone design course clearly have been met, the total impact of a community based capstone experience goes far beyond the immediate impact on the client organization or the students’ educational experiences. The total impact includes the following.

Students
• Job Offers - The quality of the students’ work has resulted in job offers to team members. Some clients have used the senior design project as an opportunity to meet students and assess their potential as employees. In several cases, members of the project team have been employed to help the client implement the project recommendations. Some of these have become permanent positions with the company. In setting up a recent project, the client stated that project team members would be given first consideration for permanent positions. This makes the project more attractive to the students and also puts more pressure on the students to complete a professional level job.

• Resume Builder - The project with its emphasis on the final product as well as the process (project management, teamwork, inter-personal and communication skills) has been a significant resume builder for seniors, especially those without industrial experience. Taking the final report to a job interview and talking about their real-world accomplishments has opened the doors for many students who are seeking positions. One 2002 graduate reported that he was one of fewer than ten people offered positions by a company out of more than 1200 applicants. His capstone design project experience was one of the keys to getting an offer. One of the major employers of our graduates has stated that the graduates of our program are “head and shoulders above any other people they hire” primarily because of their results oriented, capstone project experiences. Several of the people this company has hired had little prior industrial experience other than the capstone project, but have been extremely successful with the company.

• Job Performance Enhancer – Some of our students work full-time or almost full-time and go to school part-time. Some of these students have many years of work experience and have responsible positions in local companies. These students often appreciate the senior design course more than the more traditional students. Despite their job experiences, they report to us that, being part of a team that is trying to solve an unstructured problem, they have developed tools...
and techniques that will allow them to be more effective on their current and future jobs.

- **Future Students Recruiter** – The senior project facilities are always included when prospective students are given a tour of the department’s facilities. Often one of the senior design students will be in the project office and can discuss his/her project with the prospective student. These impromptu presentations and the impressive facilities have been valuable in convincing the prospective student to attend Bradley and major in an IMET program.

- **Underclass Motivator** – The freshmen are required to attend the on-campus presentations of the senior capstone projects. All other departmental students are encouraged to attend. The students get an idea of the expectations for the capstone project and a preview of some of the topics they will cover in their academic programs. Some of our students report that seeing the capstone projects every semester is what kept them motivated through their first 3.5 years.

**Department**

- **Financial Resources** – The fact that the department is able to deliver a professional quality product has allowed us to charge clients for our services. Charging clients for the projects has several benefits. These include:
  1) The quality of the problems given to the students has increased significantly, thus enhancing the learning experience. Companies are no longer providing projects that are “busy work” type problems, but are now providing real problems to which they expect real solutions.
  2) The almost $1 million derived from these projects has funded space and equipment for the senior design students and pass-down equipment for the department. During the last three years, the department has been able to invest more than $130,000 in the capstone design facility. Much of this has gone to new technology. One-third of the computers in the capstone design laboratory are replaced every 6 months. The replaced units are moved to the department’s regular computer lab. This approach has allowed the department to have an adequate computer lab without having to spend our capital budget on new computers. The same has been true for other pieces of equipment, such as computer projectors, digital cameras, camcorders, and laptop computers. Most of the department’s inventory of this equipment has been handed down from the capstone design laboratory.

- **Future Capstone Projects** - The level of client satisfaction has resulted in many repeat customers, thereby reducing the effort required to secure projects. The department has several organizations that are regular clients. One regional company funds one project each semester. Several other companies fund one project a year or one every 3 semesters. Being able to rely on this core group for most of the projects results in far less faculty time and effort being expended to secure new projects.

- **Projects for Other Courses** – Capstone project clients have been sources for non-funded projects for several sophomore and junior level courses. In some cases, senior students may expand their capstone project to include a project for the quality or ergonomics courses they may be taking concurrently. This enhances the capstone project and also provides a project topic for the students to use in other courses. Students in the facility layout, quality, or ergonomics courses who are not in the capstone course may still use the seniors to help identify appropriate
projects and contact people at the capstone client’s location.

- **Industrial Advisory Council** – Contacts made with clients through the capstone course have resulted in several members for the department’s Industrial Advisory Council. This association works both ways, as new projects are sometimes the result of current advisory council members becoming aware of the types of problems the students solve and the quality of their work. A properly constituted advisory council can be an excellent continuing source for projects. The seniors also present their projects to the council and receive feedback from them. This results in better recommendations and makes the council members more aware of the quality of the students’ work.

- **Faculty Awareness of Industry** – The faculty interaction with industry through the capstone projects has allowed department faculty to be aware of current industry problems and issues. Often, departmental faculty that are not part of the capstone design team are used by the student teams as consultants on their projects. This interaction helps the faculty to understand some of the current industry problems. Even if the other departmental faculty only attend the final on-campus presentations, they still get a good picture of the issues that are facing local industry.

**College and University**

- **Pillar of Excellence** – The IMET capstone design course has been identified as one of the Engineering College’s “Pillars of Excellence”. The Dean of the College includes past projects in his presentations and also uses IMET projects as a way to approach potentially beneficial industrial contacts. Most industrial representatives that visit Bradley’s College of Engineering and Technology are given a tour of the IMET Dept.’s Capstone Design facilities and a presentation of project activities.

- **Industry Contacts** – Industry contacts developed through the capstone projects often serve as a starting point for the university’s development efforts. Any proposals that are given to Caterpillar for major funding will include descriptions of past capstone Caterpillar projects. Both the number of such projects and the potential benefits to Caterpillar (well over $10 million) are presented as a way of conveying to Caterpillar why they should continue to make major gifts to Bradley. These projects have been one reason that Caterpillar has been a generous contributor to the University. Often a representative from the IMET Dept. is asked to go with a Development officer for the first meeting with a company that has been identified as a potential donor. The discussion of past projects and identifying the ways that we can help the company through future projects may result in the company becoming interested in working with the University. Such visits have resulted in new project clients and donations to the University.

- **Model for Other Programs** – Every student in the capstone design course is concurrently enrolled in the same section of technical writing. In some semesters, the IMET students completely fill this section; every semester our students are the majority of the students in the class. The linking of the capstone project with Technical Writing has become a model for Bradley’s Writing Across the Curriculum program. Only one other paired offering, CIV 100 and ENG101, link a composition and non-composition course. Our experience has shown that the linking of the Technical Writing course with the capstone design course results in students

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learning more about technical writing than taking the Technical Writing course in an earlier semester. The linking of these two definitely has resulted in a higher quality project final report. This is verified by the fact that the annual award given by the English Department for the best written Technical writing paper has been given to an IMET Capstone Design project every semester that our students have submitted an entry. This emphasis on writing has also provided the impetus for starting the Journal of Industrial Engineering Design as a vehicle for publishing IE capstone project summaries.

Summary
A capstone design project concept that uses the community as clients for funded projects gives students an exceptional learning experience and provides a great source of engineering problem solving talent to the client. In addition, it can have a significant impact on the resources available to the department, student recruiting, and the reputation the department has in the University and the community.

References


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