



## **Leveraging Cooperative Education Experiences to Enhance and Develop the Capstone Design Course**

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## Leveraging Cooperative Education Experiences to Enhance and Develop the Capstone Design Course

At Grand Valley State University, cooperative education experience is integrated into all engineering programs and is required for graduation. Beginning the summer following the sophomore year the students spend alternate semesters with an industry partner. Skills gained during these semesters are readily applied and leveraged to enhance the capstone experience that entails industry sponsored design and build style projects. The ability to comfortably interact with professionals in an industrial environment, manage projects entailing interactions with other portions of the business outside of engineering such as purchasing, skilled trades, marketing, sales and others allows a wide variety of challenging projects to be considered for the capstone design course. Frequently capstone projects are proposed by companies that currently have one or more co-op students. If appropriate, the co-op student acts as the point of contact between the student team and the industry sponsor. This minimizes the amount of miscommunication and also allows faster turn-around times for activities such as purchase orders, work orders and decision making. This allows projects which may otherwise be out of scope for a two semester course sequence to be accepted, and in turn increases the value to the sponsoring companies and the student experience. Sponsoring companies have frequently hired students that were identified as part of a capstone team that performed well. This paper will present a variety of capstone projects that were made possible by students having the skills and experience acquired through their cooperative education experiences.

## Introduction

Cooperative education programs allow students to experience the professional work environment and allows application of knowledge gained in the traditional academic environment. Multiple studies attest to the benefits of cooperative education.<sup>[1,2,3,4,5,6,7]</sup> In the engineering programs at Grand Valley State University, before beginning the capstone sequence of courses, students have completed three full semesters of cooperative education experience. During the semesters the students are on co-op, in addition to formal work activities, students are required to complete several learning modules. These modules cover topics including: professionalism in the workplace; engineering ethics; engineering economics; and project management and communications - including corporate documents (reports and memos). Leveraging the additional knowledge and skills that a student gains via co-op to undertake more challenging senior projects is the focus of this paper.

## Skills Sets Acquired Through Co-op

The skills most commonly gained associated with a cooperative education program include: improved social skills<sup>[8]</sup> (negotiating, team-building, leadership, appropriate listening and speaking skills, and basic etiquette); communication, teamwork, and understanding ethics and professionalism<sup>[9]</sup>; work skills development, career development, and academic functions<sup>[10]</sup>; and socialization to the workplace and occupational roles.<sup>[11]</sup> Perhaps first among these skills is the ability to comfortably communicate and interact with other engineers in an industrial environment. In-class presentations and technical writing are excellent methods to lay the ground work for future interactions with their industry peers. However, they cannot replace the actual experience students gain when writing technical reports, participating in design reviews and daily interaction with other professionals that the co-op experience provides.

This improved communication has allowed the capstone sequence at Grand Valley State University to take on challenging projects. Projects centered on product development, testing and automation have all benefited from the improved skill set that a student gains during co-op. The instances where the students have a capstone project sponsored by their co-op employer allows a much smoother flow of communication. Teams with this advantage typically take less time creating specifications, passing their design reviews, ordering parts and have a smoother hand-off. When reviewing projects submitted by the industry partners, faculty are much more willing to take on a challenging project if a member of the team is employed as a co-op.

Communicating with engineers entails a variety of items: face-to-face, e-mail, design reviews, technical reports and memos, part prints, board layouts... Projects entailing interactions with other portions of the business outside of engineering such as purchasing, skilled trades, marketing, sales and others require additional methods of communication.

## **The Role of Building Relationships**

In order to undertake challenging design and build projects with industry sponsors, a substantial level of trust must be established between the university and the sponsors. Such projects require an understanding of the capabilities of the student teams on the part of the corporate sponsors, as well as an understanding of the culture and expectations of their corporate partners by the students and faculty. This level of trust requires long term planning, development, and nurturing.

The engineering programs at Grand Valley State University were launched at the request of local industry in the 1980's. The programs were designed by a team of faculty in collaboration with practicing engineers from industry. The programs developed by this group are based upon university / industry partnerships including cooperative education for all students.

The co-op program is closely coupled with the academic experiences via formal feedback mechanisms. These include feedback from both the student and supervisor every semester, as well as faculty oversight including site visitations. This provides for regular interaction between the faculty, students, and industrial partners via what has become an ongoing dialog.

The partnership that was established in the 1980's continued and has matured. Very quickly, the capabilities and contributions of the students participating in the co-op program were recognized by our industry partners. This recognition, combined with the desire to infuse even more industry practice in the engineering programs led to the introduction of industry based and sponsored capstone projects. The projects are intentionally selected to provide challenging, interdisciplinary problems. The academic majors and industry skill sets of the students on each team reflect the needs of the project.

The regular interaction between the engineering faculty and our industrial partners provides excellent opportunities to identify appropriate projects for the capstone program. In addition, the knowledge of the student capabilities and confidence in faculty insight into industrial practices and expectations allows companies to propose meaningful projects that benefit both the students and the sponsor.

It is common practice for students and their supervisors to initiate discussion of potential capstone projects during the faculty site visits during the second and third semesters of co-op. Beginning such discussions at such an early date, allows for careful development of the project proposals and expectations. It is gratifying that such early involvement by our corporate partners has expanded as the number of desired projects regularly exceeds the number of projects that can be staffed by our graduating class.

## Example projects

Past capstone projects that included team member(s) that had co-op at the sponsor are shown in figures one, two and three.



Figure 1 Attwood Marine – Pump Flow Test

This particular project required knowledge of Attwood's preferred PLC's, safety standards, programming standards, product line, internal specification system and purchasing requirements. Without the advantage of the students with co-op experience and direct experience with Attwood this project would not have been attempted. The pump flow test stand has been used for the last three years and is currently in service.



Figure 2 Magnum – Lighted Dental Mirror Product Development

This project was focused on product development. Several design revisions and prototypes were created. Again knowledge of the sponsor's internal systems and capabilities allowed this project to be successfully undertaken.

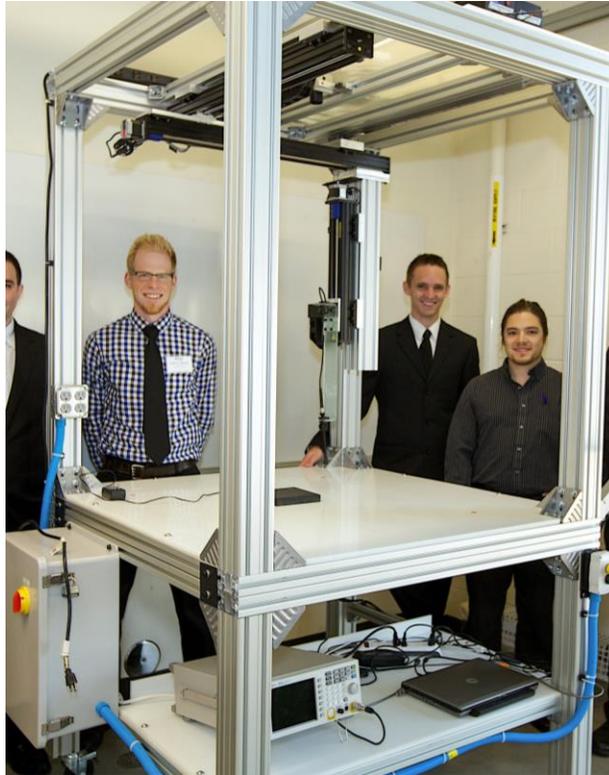


Figure 3 L3 Test Stand

This project was a tester for touch screen products, was placed in service fall of 2014 and is being used daily. A key component to the success of this project was a tightly controlled scope and specification document generated by the students. This was required because the sponsor was unsure exactly what was needed for their product. Creating and/or using these documents is an experience most co-op students will have for all three semesters of co-op.

### **Conclusion:**

The co-operative education system allows greater interaction between university personnel and industry. This interaction provides a natural foundation to build relationships outside of co-op. In this paper capstone design is discussed and highlighted but there are numerous other benefits obtained from these relationships. The other side of completing successful projects lies with the students. The technical knowledge, professional demeanor and communication skills gained through co-op allow more challenging projects to be addressed. Enhancing these skills is the benefit gained when a student is on a capstone design team that has had co-op experience with the sponsor. A further benefit to the students is they are often invited to join a sponsor's

organization after completing senior project due to the interaction they have had and the challenging nature of the project.

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