

# Bridging Capstone Design with Industry Needs through Communication, Training and Involvement

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When entering into a Capstone project relationship there are certain expectations that both industry and academia are seeking to achieve. Of course, the desired outcome is to complete a successful project and have relevant learning by students. At Brigham Young University there have been a number of teaching and coaching aids used to prepare both the students and project sponsors for success. Bridging Capstone design requirements and educational objectives with industry's willingness to partner with academia, creates an opportunity for success. This paper describes how to create a culture of communication between industry sponsors and student teams, and a discussion of lessons learned on the need for involvement from both industry and academia.

## ***Introduction***

Brigham Young University's Ira A. Fulton College of Engineering and Technology implemented a new course in 1990 designed specifically to prepare senior engineering students to be better prepared for the practice of engineering. *Integrated Product and Process Design*, referred more commonly as ME EN 475 and 476 or Capstone is this course. Students are taught how to work in multidisciplinary teams to accomplish a design and build project for an industry sponsor.<sup>1</sup>

From the course's initial inception it was envisioned that student teams would work closely with their industry sponsors and that both student and sponsor needs would be fulfilled in order to make the partnership successful. We have found that having the students learn and use a structured design process creates an effective environment for bringing industry and academia together to meet the needs of both.

This paper will first discuss the purposes of Capstone in relation to industry needs and expectations. Second it will share the importance of creating a culture of communication. Third, it will present how BYU's Capstone program trains both the faculty coach and the sponsor's liaison engineer. Fourth, the paper will discuss the importance of defining student and industry involvement. And lastly, it will conclude with a brief description of lessons learned over the past 20 plus years.

## ***Capstone Background***

The purpose of Capstone is to prepare students for the practice of engineering by having them put into practice what they have learned in their previous educational experiences. Educational outcomes for BYU's course are as follows.<sup>2</sup>

*The overall objective of Capstone is to help each student become a successful, practicing professional who*

*can make a positive difference in the world. To achieve this, each student is expected to learn to:*

- 1. Understand and apply a structured design process to complete a design project that adds real value to a project sponsor.*
- 2. Understand and apply principles of project management and scheduling to ensure that the right work is accomplished at the right time.*
- 3. Integrate the knowledge and skills developed over the course of prior education and experience to achieve high-quality engineering designs that meet customer needs.*
- 4. Participate synergistically as a team member, whether leading or following, in order to help the team succeed at the highest level.*
- 5. Grow personally and professionally, taking the responsibility to learn and work independently; seeking outside help, advice, and feedback as needed to complete the design project.*
- 6. Work hard on a challenging project, in spite of the difficulties that will arise, and couple that work with faith to accomplish an outstanding solution.*

In an attempt to better understand industry's needs as they relate to newly graduated engineering students BYU conducted a survey in 1993. The data collected is still relevant today as there continues to be lasting impressions of weaknesses in preparing students for industry practice by academia. Survey weaknesses included:

- Technical arrogance*
- No understanding of manufacturing processes*
- A desire for complicated &/or high tech solutions*
- Lack of design capability or creativity*
- Lack of appreciation for considering alternatives*
- No knowledge of value engineering*

- *Lack of appreciation for variation*
- *All wanting to be analysts*
- *Poor perception of the engineering process*
- *Narrow view of engineering & related disciplines*
- *Not wanting to get their hands dirty*
- *Consider manufacturing work as boring*
- *No understanding of the quality process*
- *Weak communication skills*
- *Little skill or experience working in teams*
- *Being taught to work as individuals*

BYU's Capstone program works closely with project sponsors to address these needs. Furthermore, when an industry sponsor spends \$20,000 on an educational grant to sponsor a project they also have expectations. They expect a collaborative effort and also expect to receive a completed project including a well-documented design, written report and functional prototype.

In collaborative efforts this year with the National University of Singapore, Pennsylvania State University and the University of Connecticut, BYU's engineering students are also learning about globalization and being interdependent with others to complete a project.

In order to manage needs of both academia and industry, it is important to first recognize the stakeholders in Capstone. They include students, faculty, industry, academic administrators and others.<sup>3</sup>

As a result of better understanding what stakeholders expect, the course better prepares both the students and the sponsor's liaison engineer for the project. The goal is that there should be "no surprises" from either party with regular communication and involvement.

### ***Managing Industry Sponsors and Student Teams***

In an effort to bridge the needs of industry sponsors and academia, it is important to manage expectations closely. Since regular communication is essential for any successful project, this section will address managing those expectations.

So what are we doing in Capstone to meet industry needs? Although Capstone's focus is to prepare students to become successful practicing engineers, the sponsor is looking for a completed project and often competent graduates they will want to hire.

### **Managing industry sponsors**

Prior to accepting a project proposal from a potential industry sponsor it is important to spend time setting expectations before final approval is granted for a project with the sponsor. This includes giving them an introduction to the Capstone program and the expected outcomes, including a copy of the *Liaison Engineer Guide*.<sup>4</sup> In our experience the more information given

up front to the sponsor the better they are prepared for deliverables, presentations and challenges.

Regular Communication via personal visits and telephone calls to the sponsor are the best way to know if their needs and expectations are being met. In addition, BYU also has a full time External Relations Manager whose job it is to not only work with industry to help recruit good projects, but also to follow up with personal visits and monitor progress. This person establishes a relationship with sponsors that can be invaluable in resolving issues.

Surveys are sent to industry sponsors three times during the year. The first survey is sent in October for initial input. This survey sends a message to the sponsor that we are dedicated to the success of the project and want feedback. The second survey is sent after the first semester has ended and second semester has begun. At this time the sponsors will have seen the preliminary design presentations and have a better understanding of where the team is heading. Finally, after the school year has ended, a final survey is sent to gather information on the entire project. These three surveys provide invaluable feedback which allow for Capstone course adjustments and/or changes if required, prior to the beginning of the following school year.

### **Managing student teams**

There are a number of action items required of students at BYU to help manage and strengthen their communication with the industry sponsor. Students attend one-hour weekly Capstone class lectures. A sample of the lectures taught include topics such as identifying and interpreting customer needs, functional specifications, concept generation, prototyping, documentation, and economic analysis. Student project teams are also required to send a weekly progress report to the sponsor. Student teams communicate weekly with the liaison engineer in a telephone or web based video conference. During this meeting they ask questions, receive answers, gain approvals, and also receive real time feedback. These communications are documented in the students' record portion of the *Product and Process Development Guide and Record book* or *Guidebook*.<sup>2</sup> The teams also give two design reviews each semester to the course instructors which affords them a safe learning environment to share their work and receive feedback. Semester final presentations are also given. The results of these efforts help the students bridge the communication gap that might otherwise exist between academia and industry.

### ***Faculty Coach and Liaison Engineer Training***

One of the most important items to address in bridging Capstone design with industry is setting the expectations of the faculty coach and liaison engineer. Better

communication and the opportunity for a successful project is achieved once all understand their responsibilities.

### **Liaison engineer training**

When the liaison engineer representing the sponsor understands their role, the design process is better realized by the students. At BYU we use a *Liaison Engineer Guide*<sup>4</sup>, which is a simple 8 page training guide to help the new liaison engineer in their interactions with the team. This guide includes an overview of Capstone. It also creates an opportunity to set expectations up front.

One section of this guide describes eleven specific accomplishments that students participate in. Some of these expectations include providing regular communication with the liaison engineer, generating and selecting design concepts, developing proof of concept hardware, participating in design reviews, formally presenting their work with final documentation, and a completed working prototype.

The *Liaison Engineer Guide* focuses on four main areas including monitoring progress, maintaining team relationships, evaluating project results and providing regular and honest feedback.

Responsibilities are summarized in the conclusion called “Keys to Success as a Liaison Engineer”. These include:

1. *Support the design process as taught in the class. You may want to add your own strengths, but please don't take off on an extremely different approach.*
2. *Clearly communicate your perception of how the team is progressing with the faculty coach and team. If you are unhappy, let them know about it. If you feel like the team needs to hear some specific comments, tell the coach.*
3. *Develop an expectation that the project will be successfully completed on time.*
4. *Make time available for your team. Communicate with the coach and team weekly.*
5. *Let the team know you are counting on their work. Explain the impact that the project will have on the company.*

### **Faculty coach training**

On average there are 30 Capstone teams each year with typically half of the coaches coming from industry. The balance are full-time faculty from various departments on campus. Coaches are generally given a project that most closely fits their professional backgrounds.<sup>5</sup> Taking the time to properly train the faculty coach is an important aspect of BYU's Capstone course. To help with this training BYU has developed a pamphlet titled the *Faculty Coach Guide*<sup>6</sup>. The following section will

give a brief description of what can be found in the *Faculty Coach Guide*.

### **Faculty Coach Guide**

After a brief introduction, the guide explains expectations required of a faculty coach. Some of these include regular communication with the sponsor's liaison engineer, becoming familiar with the Capstone policies and procedures, attending class lectures, attending weekly team meetings and participating in faculty coach training meetings.

A critical component to becoming an effective coach is creating and maintaining a relationship with the liaison engineer. Meeting the liaison engineer immediately following the project assignment creates an opportunity to bridge potential concerns by both parties. Thereafter, regular communication is the key to resolving issues. Oftentimes the scope of the original project will tend to “creep” so that it includes more than the students can accomplish or the opposite can happen where the scope is narrowed so that the students are not challenged. Having regular communication between the faculty coach and the liaison engineer benefits all stakeholders.

The *Faculty Coach Guide* concludes with a section that outlines a roadmap for success. These suggestions include: choose a team leader early, learn the Capstone design process, learn and promote the Capstone course outcomes, develop and maintain an effective team, communicate regularly with the sponsor and team, provide regular feedback, be a coach, encourage your team to write often, each team and project is different, be available, seek help, have fun.

Finally another way to manage the expectations of the faculty coach is to hold regular coach meetings, which includes following a formal agenda. Three coach meetings are held each semester. The first coach's meeting, held prior to the first day of class, is designed as an introduction to Capstone and understanding of responsibilities. Setting these expectations at the beginning of the school year is critical prior to working with student teams.

### ***Establishing Guidelines for Student and Industry Involvement***

It is important to establish guidelines at the beginning of the project for both the students and industry sponsors. Having an understanding of each other's involvement from day one helps ensure a more open line of communication rather than assuming the worst when a problem arises. The *Guidebook*, given to students their first day of class, gives them the required expectations for the two semester course and their work on the project.

## Student involvement

For the students there are weekly team progress reports that are emailed to sponsors. A weekly telephone or video conference is also strongly encouraged. Other expectations include regular student design reviews and formal presentation “practice runs”, both of these being held with the instructors so that critical feedback can be provided. The instructors also formally review and grade the team’s final design and hardware or prototype.

We quickly strengthen the bridge between academia and industry when students understand their involvement is critical as it relates to not only their grade in the course but also their industry project sponsor’s needs.

## Industry involvement

It has been our experience that excellent communication and involvement from industry sponsors creates an environment where student teams feel encouraged and exert a great amount of time and energy to please the sponsor along with receiving a grade. The reverse is true as well. When the industry sponsor does not have enough time to communicate regularly and give needed feedback, the team becomes discouraged and the project outcomes may become weakened as a result. Industry sponsor participation in the formal design presentations, weekly telephone/video conferences and feedback on weekly progress reports are important aspects in bridging the needs of both industry and the students learning experience.

## Lessons Learned

The Capstone learning experience is unique and often new to students. They are accustomed to solving theory based problems that are not open-ended and have seldom worked in a team environment. With Capstone they have a new challenge of working on a “real world” problem that is open-ended in nature. The students are also required to work in multidisciplinary teams and must learn team dynamics to accomplish a successful project.<sup>7</sup> We have learned that working on a Capstone project can be a very valuable aid for preparing students for what is ahead in industry once they leave school.

Evaluation and assessment of a project can also be very challenging and difficult. Each project is unique and has its own set of expectations. In order to facilitate this challenge students are taught a structured design process and are evaluated based on their individual learning of the course material, their team project grade, and individual contribution to the team. Although there is much subjectivity to evaluation and assessment in a Capstone design course, we have learned that when the expected outcomes are outlined and properly presented, both are more likely to be satisfied with the results.

## Conclusion and Recommendations

We have addressed the purposes of Capstone in relation to industry needs and expectations and shared the importance of creating a culture of communication when managing an industry sponsor as well as student teams. This paper also discussed how BYU’s Capstone program seeks to effectively train both the faculty coach and the sponsor’s liaison engineer, with specific training guides, so each begins the project with similar expectations as well as the importance of student and industry involvement.

Partnering with industry, while understanding the challenges of both industry and academia, we have found to be a very significant way to prepare engineering students for the practice of engineering. Students and industry sponsors learn that customers’ needs can be met while using a design process and applying that knowledge to real-life industry sponsored projects.

## References

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