Merging Design Competition and Industry Sponsored Projects

Rebecca Blust, David Myszka
Engineering Technology

University of Dayton

Abstract

Over the past several years, the use of competition-based projects in engineering and engineering technology education has dramatically increased. These competitions take on many different forms. Many individual technical organizations sponsor a collegiate design competition. Additionally, many schools conduct their own internal competitions. These projects provide the benefit of the increased learning from student-focused experiences with the additional benefits of motivation and reward that stem from design competitions. Further, the recent popularity of reality-television provides the evidence of the entertainment value from a task-oriented competition.

Like other institutions, the Engineering Technology programs at the University of Dayton have also introduced design competitions throughout the curriculum. Because the business environment is dynamic, we as educators are continuously seeking opportunities to improve our processes. Therefore, in an effort to increase student exposure to realistic business situations, we have extended these competitions and integrated a portion of them into our industry-sponsored senior project course. When using competitive teams, the client presents an open-ended project to multiple teams. The teams work in relative isolation to provide an optimal solution for the company. Student teams benefit from the design competition experience while the client gains multiple solutions to their problem. Advisors provide a healthy environment for the competition, stressing ethics and honorable business practices. This paper will discuss the rationale of this venture, methods, current models, administrative issues and the results of this effort.

1. Introduction

Capstone Projects

Over the past two decades, capstone project courses have emerged as an essential element of a technical education. In fact, this experience has become a "residency-like" requirement for engineering and engineering technology graduates. These projects have evolved to team based, interdisciplinary, industry sponsored experiences, which often require prototypes or another form of verification[6].

An all-inclusive definition of a project-based course does not exist. However, important characteristics include[4]:

- The primary objective of the course is to complete a relatively large project, working through all phases of a design and development process.
- All course activities support the completion of the project. Student learning occurs through these activities.
- Students are evaluated solely based on their performance related to the project.

The benefits of capstone design courses have been well documented[4,5,6]. The most important are that they prepare a technical professional for the creative solution to constrained problems that will be come the trademark of their career. These capstone experiences with open-ended tasks allow entry-level graduates to "hit the ground running".

Competition

Competition is most often associated with an athletic contest. However, in general competition is any opportunity, in which an individual, team or organization strive against others to achieve a goal, such as a victory[1]. Competition makes people stronger. It motivates the contestants to try to win the prize (and recognition) that accompanies a victory. Competition that has led to breaking barriers such as climbing Mount Everest, running a four-minute mile, and hitting more than 63 home runs in a season. In a free-market economy, competition has strengthened corporate enterprises and our power as consumers.

In our culture, competition is entertainment. Professional sports charge spectators high ticket prices, yet consistent sell-out stadiums. Reality-shows on television are enormously popular, and the (mostly outrageous) competition is a core element.

These benefits can be directly applied to technical experiences through student projects. A competition-based project refers to a situation where a team of students are assigned a project, in which at least one other team has is to solve the same problem with the same constraints. Additionally, the deliverables (such as reports, presentations, prototypes, etc.) produced by the teams are objectively evaluated in a manner that allows them to be ranked relative to one another.

Like capstone projects, the advantages of student competitions are well documented in various disciplines of engineering and engineering technology[1,2,3,7]. Competition-based projects are motivating, build stronger skills, and entertaining for participants and observers.

Merging the Two

The Engineering Technology programs at the University of Dayton have experimented with utilizing competing teams in their industry-sponsored, capstone project experience. A description of the specific strategies and procedures for this implementation is given below.

2. Interdisciplinary Capstone Course

Course Description and Objective
The Senior Project course at the University of Dayton is a two-credit course that is required for all majors in the Department of Engineering Technology. These majors include Computer, Electronic, Industrial, Manufacturing and Mechanical Engineering Technology. Students work in small, multi-disciplined groups to develop an engineered solution for an industry client. Two faculty members, with different areas of expertise, serve as student advisors. Each industry project has an individual that serves as the company representative and liaison for the project. Students are required to function in a business environment by interacting with their clients in an industrial setting.

The intent of the course is to provide a realistic, integrated, and interdisciplinary experience for graduating seniors in Engineering Technology. Our primary objective in the Engineering Technology program at the University of Dayton is to develop technically competent entry-level engineers for private industry. Providing the opportunity to work in a "real world" environment enhances the student's educational experience and offers additional breadth to their degree. In addition, this class facilitates an environment that will allow students to gain practical experiences, which will present a smooth transition into industry.

Project Solicitation and Selection
Prior to the start of the term, the course advisors review a list of possible client projects. These projects can come from countless industry contacts. The University of Dayton's Design and Manufacturing Clinic acquire most projects. The advisors compare the project list with the class roster. The goal is to select projects that fit the class profile. This process is tedious and time consuming. We have encountered several semesters when the number of students in one discipline strongly exceeded others and there were not enough projects to cover that specific discipline. However, if the client was willing, we had a solution that would double the amount of information the client would receive and in addition, solve our imbalance of projects that fit the class profile. We elected to use competing teams. This involves constructing two identical but separate teams. Each team would have different members from the same disciplines with similar technical abilities.

General Format
After the advisors determine the industry sponsors, we formally meet with the students in a traditional classroom environment. We address our students for the first time with the statement, *"Welcome to YOUR Senior Design Class. This is a class like no other class you have had before; where you, (the student) are both the teacher and the student."* This statement baffles many students at first. However, after a few weeks, they understand the true meaning behind the statement. The class formally meets for two, one hour and 40 minute sessions each week. Our expectations regarding each individual's time commitment is roughly 8-9 hours per student, per week.

The first few classes are conducted as typical lectures, where the advisors formally present project material in addition to scheduling the initial on-site client visits. Each project is presented to the class, without identifying the company and client name. This is to avoid any bias or conflict of interest. Each student independently notes their desire to work on a specific project and scores each accordingly. The project that would require two competing teams was not disclosed at this time. It is felt that the competition might influence their decision (either negatively or positively).

Teams are selected based on their project preference, along with their personal work style and strengths, which are obtained from survey instruments. The focus of the entire semester is on meeting the needs of the client.

3. Competing Teams

Setting the Stage

During the second classroom meeting, the advisors inform students of the makeup, leadership and industry sponsor for each project team. In addition, the advisors also announce the project that will involve competing teams. For example, we explain that two out of six total teams will compete in a typical business setting for the client's business. Each team will work toward a design package that will incise the client to select their product. Both teams will participate in the initial client meeting. This is to ensure that the client communicates the same information to each of the teams. At the end of the client presentation, each team has the option to meet independently with the client to ask specific questions regarding the project. Most questions the teams ask are the same. However, a few questions reflect different approaches, understanding and responses to the problem. At this point, the competition begins. Now the advisors must communicate a few ground rules to the project participants.

Ethical Dilemmas

The word competition is often associated with negative business environments. Therefore, if we wanted teams to perform ethically and respectfully, we had to communicate our expectations to the teams and their leadership. Students perform and act to the expectations set by their leadership. As advisors, our responsibility to set the stage to ensure this happens. We conduct separate meetings prior to the initial client meetings to discuss ethical dilemmas that are associated with competition. Team leaders are strongly encouraged to adopt professional, business attitudes. These attributes need to be prevalent in their leadership practices. We discussed openly the expectations for team conduct and that a portion of their grade would reflect their actions in honoring that commitment. We wanted to facilitate an atmosphere where teams can participate in a "healthy" competitive environment.

Not every element of the ethical business practice meeting is effective. Our student leaders are often plagued with peer pressure to participate in espionage. Student members feel stress during competition and may not have the skills to handle the insecurity and uncertainty of the situation.

The key is for the team leader to resist being drawn into this situation. Often, this is not easy for the team leaders. However, in most cases, leaders handle these detours with maturity and professionalism.

Class Format

The class session following these meetings is traditional in nature. The advisors relay project proposal information and recommended content for the design process procedure. The remainder of the class sessions is used for student teams to meet and discuss the progress of their individual projects with no additional lecture from the faculty advisors.

Each of the competing teams meets in different locations located in separate areas of the building. This required the advisors to travel from room to room during each of the class sessions. During these class times, design reviews are scheduled for each team every other week during the semester. During these reviews, each team presents the status of the project to their peers and advisors. In addition, each team is required to submit a progress report that communicates the details of the status of the project. Each individual team member submits the contribution and status of his or her contributions to the team project. The team leader drafts the project progress report, attaches the individual progress reports to the document, and sends the document to both the client and the advisors.

Project Examples

Process Changeover - During the winter term of 2004, we conducted the first project competition. The project was to reduce the die change time for a local stamping manufacturer. The client communicated the current change times included a range from 1.5 to 2.0 hours. The client requested that the teams investigate methods and reduce the change times to 15 minutes.

The number and discipline of students for each team were the same. Each team had six members. There were four students from industrial engineering technology, one student from mechanical engineering technology and one student from manufacturing engineering technology. We were very careful to ensure parity among each team with regard to technical competence, creativity, leadership and work ethic.

Each team used the Single Minute Exchange of Die (S.M.E.D.) approach to solve the problem. Each team conducted a thorough time study of several different die changes conducted on various shifts. They organized their data using Pareto analysis charts and brainstormed solutions. However, the solutions generated by each team to reduce high Pareto items, were dramatically different.

Each team communicated with their client independently of each other. Each group would eventually encounter similar obstacles with their client or proposed solutions. This gave the project some continuity. Student teams worked hard to develop solutions to each problem. At the end of the semester, the student teams presented their model to the client independently of each other.

Amazingly, each team was able to simulate their engineered changes to the current changeover process in order to demonstrate the attainment of the 15-minute goal. Both teams used different methods/solutions. The client was elated to hear the presentations. They were able to implement the best practices from both presentations and integrate them into their process. This enabled the client to reduce their changeover times even further.

Vertical Winch Profiler Redesign – The second competition was conducted during the fall semester of 2005. The client requested a solution to their current design, which was originally intended for open water deployment in static environments. However, market conditions recently changed and now there is a need for these systems to be deployed in dynamic environments. The dynamics caused components on the system to fail prematurely.

Each team approached the failure analysis differently. One team constructed a system that would simulate the dynamic motion effects to the system. The other team used an analytic approach to determine the forces acting on the current system components. Once each of the teams attained the force at which the current gear drive system would fail, they each developed solutions and prototypes to simulate their solution that remedied the problem.

Both of the student teams wanted to view each other's final presentation to the client. This was truly an eye-opening experience. The students were amazed at the similarities of the obstacles each group identified in addition to the continuity of the designs during the conceptual phase of the project. However, each of the final solutions was dramatically different. The first team, Team A used a hydraulic pump/motor combination. The second team, Team B, recommended two solutions. The short-term solution was a field kit that would replace the failing part with a more robust component. The long-term solution entailed a redesign that incorporated a direct drive system with a much larger motor. The client was impressed with different elements of each of the designs. There were pros and cons to both.

4. Conclusions

We conducted surveys with the students, industry clients and the coordinator of the University of Dayton Design and Manufacturing Clinic in order to assess the value of the process. The feedback was very similar. Each stated advantages and disadvantages to the model.

Advantages

- Client Sponsor

  Industry sponsors receive input from several sources. In many cases, the sponsor of a project wants to receive fresh ideas and this provides multiple design concepts that would yield an effective solution.

- Student Teams

  A team may be motivated to perform by the shear "competitive nature" of the project. Fear that the alternate team may outperform them is sufficient motivation. This is similar to real world situations when multiple firms may be competing for a contract and must provide a better product then their counterparts. Additionally, experiential learning regarding competition is a valuable opportunity.

- Design Clinic Coordinator

  Several perspectives from Steven Covey's book, "7 Habits of Highly Effective People" address the win-win situation as well as synergy. It could produce a win-win situation for all if multiple teams were permitted allowed to share their designs and work together at the end to produce a superior hybrid design. One plus one may equal more that just two. In addition, the result of assembling multiple perspectives may produce a superior product. This may be our next step in this process.

Disadvantages

- Client Sponsor

  Since both teams were isolated from each other, it does result in some redundancy in the time required by the corporate sponsor. However, according to the corporate sponsors from the example projects cited above, the additional time commitment was not very severe.

- Student Teams

  There is always a risk of encountering industrial espionage with members of one team trying to steal another's ideas. There have been situations in other design classes that have experienced one team abandoning their design and copying the other team's solutions.

- Design Clinic Coordinator

  In most cases, sponsors are charged a $3,000 fee for these projects. By assigning two or more teams to work on the same project decreases the amount of income that supports the course.

5. Summary

The Engineering Technology programs at the University of Dayton have incorporated competing teams on industry-sponsored projects as part of the capstone course. The student teams work in relative isolation on an industrial project to provide, with the goal of providing an optimal solution for the company.

Student teams benefit from the design competition experience while the client gains multiple solutions to their problem. However, there is a downside in that the commitment from the client nearly doubles, as multiple teams request information and feedback.

In addition, funding is lower than executing independent projects, as the sponsor is charged for a single project. Still, the benefits of competition, as witnessed in student performance, outweigh the drawbacks.

References

1. Cooley, W, et al., "Competitions as a Vehicle for Teaching Engineering Design", Annual Conference of the American Society of Engineering Education, Charlotte, NC, (1999)
2. Devdas, P., et al., "Using Design Contests to Enhance Manufacturing Education", Annual Conference of the American Society of Engineering Education, St. Louis, MO, (2000)
3. Dave, J., Boronkay, T., "Using National Design Competition Projects as a Component of a Lower Division Course", Annual Conference of the American Society of Engineering Education, Milwaukee, WI, (1997)
4. Engebretson, A., Meysenburg, M, "Project-Based Courses", Annual Midwest Instruction and Computing Symposium, Duluth, MN (2003)
5. Lamancusa, J., Soyster, A., George, R., Industry-Based Projects in Academia: What Works and What Doesn't, Annual Conference of the American Society of Engineering Education, Milwaukee, WI, (1997).
6. Myszka, D., "We've Finally Done It: An Interdisciplinary, Industry Sponsored Design and Build Capstone Course", Annual Conference of the American Society of Engineering Education, Nashville, TH, (2003)
7. Orlandella, M., Zeigler, T., "Student Team Competitions: A Path to Creativity and Problem Solving in Civil Engineering Technology", Annual Conference of the American Society of Engineering Education, Montreal, ON, (2002)

Bibliography

REBECCA P. BLUST
Rebecca Blust is currently an Associate Professor at the University of Dayton. Previously, Rebecca has had a 12-year career with the Goodyear Tire and Rubber Company. Rebecca is also the Assistant Director for the Industrial Assessment Center at The University of Dayton. Rebecca's extensive industrial background facilitates excellent learning for students by combining practical experiences with technical knowledge.

DAVID MYSZKA
Dave Myszka is a Professor of Engineering Technology at the University of Dayton. Dave is a Registered Professional Mechanical Engineer in Ohio and is actively involved in applied research with industry. Dave received a B.S. and M.S. degrees in Mechanical Engineering from the State University of New York at Buffalo in 1985 and 1989, respectively. He also received an M.B.A. degree from the University of Dayton in 1996.