Fostering Sponsor and Mentor Partnerships in the Capstone Design Course at the University of Oklahoma School of Electrical and Computer Engineering

Jerry Crain and Cliff Fitzmorris
University of Oklahoma

The experience of working with a practicing engineer on a project that is important to the sponsoring organization is an important aspect of the capstone design course at the University of Oklahoma School of Electrical and Computer Engineering (OU/ECE). Although we believe that this approach provides many benefits to the student, external projects can provide a real challenge to the instructor of the course. Sponsoring organizations and mentors must be found and the relationship must be nurtured so that the organization and mentor will be a "repeat customer" by providing future projects. Fostering the sponsor/mentor relationship requires an understanding of what motivates organizations to sponsor a capstone design project, what motivates individual mentors to participate, and what defines a suitable capstone design project.

Course Background

Capstone design in the OU/ECE program is a one-semester course. The students are assigned to two teams of three-to-four students to independently work on each design project. The course typically has an enrollment of between 15 and 50 students. As reported in the 2008 conference, the Capstone program at OU/ECE depends heavily on having two to five industry sponsored projects each semester[1]. Projects are provided by private industries, government agencies, and faculty (occasionally from other university departments). Each sponsoring organization provides a one or two page Statement of Need, a mentor that is responsible to act as a single point of contact for design information, and funding to develop the product. Mentors provide project requirements, attend design reviews, and participate in the evaluation of their assigned students at the end of the project. The students are expected to provide weekly activity reports, conduct a preliminary design review (PDR), a critical design review (CDR), and a final project presentation.

Motivating Factors for Organizations and Mentors

To develop a long-term relationship with a sponsoring organization or mentor, it is important to understand what motivates them to work with the capstone design course. Usually the organization is capable of completing the project on their own (although there are important exceptions). Without appropriate processes, discouraged mentors may sometimes find it easier to just do the work rather than to act as the interface for two teams. Looking beyond the obvious benefit of receiving a completed project, we have identified several key reasons that organizations and mentors may be motivated to work with the capstone design program at OU.

Before the discussion about specific motivating factors for sponsoring organizations and mentors, it is important to recognize that those are two separate entities. It is possible to have a project in which the sponsoring organization is motivated, but the mentor is not. This can lead to a mentor who only provides the minimum required support, spotty design information, and is not responsive to student requests for help or information. It is also possible to have a situation where the individual mentor is motivated but the sponsoring organization has merely lukewarm feelings toward the partnership. This will often lead to one or two good projects but the relationship will fade away after that particular mentor is no longer able to participate. The objective of our program is to develop a highly engaged mentor (good support) who is in part motivated by approval from Engineering

Directors at his/her sponsoring organization thus generating long term partnerships.

Sponsoring Organizations

The single most important motivation for large organizations to sponsor a capstone design project is to view the sponsorship as an enhanced recruiting tool. If a company or government agency provides a design project, that organization will be able to interact with and evaluate six-to-eight engineering students who are interested in technology appropriate to their products. The sponsoring organization has a chance to evaluate the students' technical abilities, project management skills, communications skills, and work habits. As the students work on the project, they will develop a career identity[2] that is aligned with the sponsoring organization, enhancing the sponsor's ability to recruit those students. Responding to this motivation means that the course structure must provide multiple opportunities for the team to interact with the mentor. Specifically in our program, the students write Weekly Activity Reports, perform two design reviews, and the capstone final project presentation is held at the sponsor's site during work hours so that engineers and engineering managers can attend. All of these are opportunities for the sponsor and mentor to observe the capstone design students assigned to them.

The single most important motivation for a small business or a start-up company to sponsor a design project is to accomplish a task or research an area that the sponsor does not have the resources to accomplish or research on their own. Responding to this motivation means fully understanding the requirements of the project and assigning the appropriate students to provide complete and high quality work.

There are three other important motivators for engineering directors at sponsoring organizations. The first is the opportunity to provide project management experience for the engineer they choose to be the mentor. During the final project presentation, the engineering director may not only be evaluating the student team but also the quality of the support and guidance provided by the project mentor. The second motivating factor is that the engineering organization may be able to get a project completed that will improve a process or reduce cost, but cannot get enough internal traction to be completed internally. Responding to this motivation means ensuring that the students deliver complete and high quality work. The third motivating factor is that the sponsoring organization may receive some intangible benefit from partnering with the university. It reflects well with corporate or community interests for an Engineering Director to be seen volunteering to help the next generation of engineers.

Mentors

An engaged and enthusiastic mentor has a significant impact on capstone student satisfaction and project success[3]. In our experience, there are two primary motivations for engineers to volunteer to mentor a project and many secondary motivating factors. The first primary motivation is that the engineer has a need small enough that the company cannot assign sufficient resources to complete it but it is too large for the mentor to accomplish alone. This is a desirable situation because the mentor will be very motivated to provide support to the student teams because he or she will directly benefit from a successful project. Responding to this motivation means encouraging the students to provide high quality and complete deliverables. The second primary motivator is simply that the engineering director has approved of the mentor taking on the task.

Secondary motivators for mentors are the ability to "make a difference" for engineering students, a good reason to visit campus, and improved status within the mentor's engineering organization as a result of being associated with the OU engineering department.

Choosing Projects for the Course

Good projects have the following attributes: submitted by a sponsor who is a potential employer of our students, mentored by a motivated and competent individual, and produces a product that will be used on delivery. Students must believe that the project is important to the sponsor and mentor[4]. We are always vigilant for opportunities to develop new sponsors. As the old adage goes, new friends are silver while old friends are gold so our processes are focused on customer satisfaction: students, mentors, and sponsors. The data in Table 1

demonstrate the challenge of developing a broad base of sponsoring organizations while nurturing those relationships into rich sources of future projects.

Mentors and Sponsoring Organizations are Supported by Specific Course Features

Weekly Activity Reports (WARs)

Each student team is required to provide an update to the project mentor every week. The mentor can provide guidance to the teams based on the status updates and also ensure that the project is on track and meeting the requirements. The mentor can also choose to meet with the team as needed. Mentors may forward these reports to their engineering director to validate additional needs or demonstrate key accomplishments.

Preliminary and Critical Design Reviews

The PDR, at 4-weeks ARO addresses the requirement, the baseline approach and Budget Estimate. CDR, at 7-8 weeks ARO focuses on detailed design, features and functions. Material purchases other than long lead items follow CDR. These two major design reviews provide the mentor an opportunity to evaluate the project progress, ensure the project is aligned with the project requirements, and give technical feedback to the team. It is vital to understand that these are also opportunities for the mentor to evaluate the communication skills, project management skills, and understanding of business realities of the students assigned to his/her project. For this reason, each team member is required to present part of the presentation. Mentors and instructors ask questions of each team member. The PDR is a formal review, held in a conference room, and the students are expected to have a professional appearance. These reviews are held on campus which gives the mentor a good reason to visit campus. They are held in the evening to accommodate mentor schedules.

Final Presentation

The final presentation is held at the sponsor's location during working hours so that the engineering director, the mentor, and other engineers and users from the sponsoring organization can attend. The students formally present the final project and field questions from the mentor, instructor, and members of the sponsoring organization. This is a motivating factor for the students and although it is stressful, they have shown very positive response to this opportunity. Their performance, combined with feedback from the mentor gives the sponsoring organization a fairly accurate assessment of each team member's communication, technical, and project management skills (hireability).

Mentor Evaluations

After the PDR, CDR, and final presentation, the mentor is asked to evaluate each team and team member based on their technical skills, presentation skills, ability to answer questions, and appearance. The mentor knows that these scores factor into each student's final grade so they realize that their feedback is valued. After completion of the project, the mentor is asked to evaluate the overall experience in terms of process, product satisfaction, and technical performance of the team.

Results

There have been 96 capstone design projects in the OU/ECE program since the Fall 2000 semester (see Table1, next page). Of those 96 projects, 86 came from sponsors who had submitted at least one other project. In other words, 90% of our projects have come from sponsors that found the OU/ECE capstone design project rewarding enough to provide another project. In addition, 50% of projects are mentored by individuals who have mentored more than one project. Our most successful relationships in terms of repeat projects are with the National Weather Service (16 projects, 7 mentors), Oklahoma Department of Transportation (8 projects, 3 mentors), Ditch Witch (6 projects, 4 mentors), and OrderMatic (5 projects, 1 mentor). Some of our most satisfying partnerships have been with small companies or startup companies who have continued to come back to the capstone design program to enhance their products.

Although it is not possible to examine the relationship with each of our partners here, we can look at one, the Radar Operation Center (ROC).

The ROC is located approximately 10 miles from our campus. The ROC Engineering Director and managers use the capstone program to evaluate future candidates for employment. Each semester, the ROC

Engineering Director polls the engineers for projects that would be suitable for the Capstone program. Typically, the projects are either troubleshooting aids or prototypes of design improvements that individual engineers would like to develop but do not have the resources to undertake. Sometimes the project mentor is the engineer who suggested the project, but sometimes the mentor is a newer engineer who needs project management experience.

Conclusion

The capstone design course in the Electrical and Computer Engineering program at the University of Oklahoma depends on a steady stream of projects from sponsors. Keeping the project stream flowing means developing long-term relationships with sponsoring organizations and mentors. We have presented factors that we believe motivate our sponsors and mentors and specific course strategies we use to satisfy those motivational factors. The result is that we have developed a wide range of sponsoring organizations on whom we can depend on as sources of new projects semester after semester.

References

1. G. Crain and M. P. Tull, "A Capstone Course Targeting Industry Transition", Proceedings of the American Society of Engineering Educators 2004 Annual Conference and Exposition, Salt Lake City, UT, June 20-23, Session 1325; http://www.asee.org/acPapers/2004-1900_Final.pdf
2. V. Isomottonen and T. Karkkainen, “The value of a real customer in a capstone project”, IEEE 21st Conference on Software Engineering Education and Training (CSEET 2008), 2008
3. R. Stanfill and T. Rajkumar, “The liaison engineer's guide: A resource for capstone design project industrial sponsors and faculty mentors”, ASEE Annual Conference and Exposition, Conference Proceedings, 2009
4. Gorka, S., Miller, J. R., and Howe, B. J. 2007. Developing realistic capstone projects in conjunction with industry. In Proceedings of the 8th ACM SIGITE Conference on information Technology Education (Destin, Florida, USA, October 18 - 20, 2007). SIGITE '07. ACM, New York, NY, 27-32.

Table 1: Sponsoring Organizations and Total Number of Projects

Sponsor Information		
Name	Type	Total
Total 2000 - 2009		96
Faculty	Faculty	16
Radar Operations Center	Government	16
Oklahoma DoT	Government	8
Tinker Air Force Base	Government	1
City of Del City	Government	1
Ditch Witch	Private	6
Seagate	Private	4
Carrier Access	Private	3
Schlumberger	Private	2
National Instruments	Private	2
Hydril Company, LP	Private	2
Raytheon	Private	2
Flight Safety International	Private	2
Lucent	Private	1
Michelin	Private	1
Oklahoma Gas & Electric	Private	1
OrderMatic	Small Bus.	5
Ekips Technology	Small Bus.	4
Power Costs Inc	Small Bus.	3
Phi Technologies	Small Bus.	2
Scott Sabolich Prosthetics	Small Bus.	2
GreenLine/TradeHelm	Small Bus.	2
Berge A/C	Small Bus.	1
HandiBoard	Small Bus.	1
United Cultural Materials	Small Bus.	1
PCI-Dynatrol	Small Bus.	1
Midland Engineering	Small Bus.	1
Graham Services	Small Bus.	1
Burford	Small Bus.	1
Hawkeye Innovative Soln's	Small Bus.	1
Red River Automation	Small Bus.	1
Vertex RSI	Small Bus.	1