Using Graduate Assistants as Project Advisers for Industry-Sponsored Capstone Design Projects

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Capstone design courses across the United States are increasingly providing students with projects funded by industry partners. The Oregon State University Mechanical, Industrial, and Manufacturing Engineering Capstone Design course utilizes industry sponsored projects and uses a results-driven assessment of student performance to ensure deliverables. The inherent inexperience of undergraduate students can make running these type of courses challenging to all those involved. This paper proposes using Graduate Assistants as the project advisers to fulfill many key roles that compensate for some of the inexperience students may have. For industry-sponsored projects, when compared to faculty, Graduate Assistants tended to be more accessible to students, sponsors and instrucotrs, they were easier to hold accountable and keep motivated, they streamlined the communication process, they were effective as project managers, and they provided accurate assessments of student performance. Graduate Assistants also benefitted from this arrangement by gaining project management, technical advising and grading experience. There may be concerns over the lack of experience and maturity of the Graduate Assistants, which were remedied by having faculty members supporting each Graduate Assistant.

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Introduction

Capstone projects are used in almost every university in the United States that offers an engineering degree.[1,2] These courses fulfill key requirements outlined by the Accreditation Board for Engineering and Technology (ABET).[1,3,4] They are used to teach the design process while giving students the ability to apply their knowledge in a real-world scenario. They serve to bridge the gap between classroom learning and application[5]. Though every course is different, all courses require that students design a solution to a given problem, and then, in many cases, implement this design. These courses not only give students the chance to apply their knowledge in real-world scenarios, but they provide a method for assessing a student's engineering abilities as a whole.

One particularly effective style of capstone design course uses a system where teams of students are given their own projects, sponsored by industry partners.[1,2,4,6] Businesses are looking for engineers that have more real-world experience so there is a strong push for universities to provide engineers that have experience with realistic projects.[6] This approach helps give students a wide range of unique design opportunities while cultivating many of the skills that have been taught throughout a student's undergraduate experience.

There are often concerns from course instructors that there will not be enough projects for the students, and industry sponsors are often hesitant to commit funds at the risk of an unusable deliverable. The most effective solution to both concerns is to have a portion of student assessment based on how effectively the student's designs meet the project requirements set out by the project sponsor.[4,5,7] This provides a contract between the project sponsor and the group of students. Industry sponsors are more comfortable investing in projects and course instructors are less likely to have a shortage of projects because industry sponsors will return as a result of positive project outcomes.

The arrangement is beneficial for the students involved as well. Just as with normal classes, a student's grade depends on their performance in the class, but, even beyond this, there is an added incentive to perform because the project sponsors are relying on the level of work they can provide. Providing students with an opportunity to be responsible for a project will motivate them and give them realistic work experience.

One of the largest obstacles that must be overcome with all Capstone Design courses is the inherent lack of experience of the students. Many instructors will claim that the students are simply incapable of performing the necessary type of engineering required to reach project goals, but it has been observed that students may achieve success provided they receive adequate advisement, guidance and evaluation throughout the design process. There is the need for some sort of supervision, both in terms of the course work, and project management. The logical source for this

advisement would be the course instructor or another faculty project adviser. This paper is proposing that graduate research and teacher assistants be employed through the course instructor to oversee each student group. It has been observed that Graduate Assistants are the best choice for project adviser with industry-sponsored projects.

This paper is presenting the observed benefits of using Graduate Assistants (GA) as project advisers for the Mechanical Industrial and Manufacturing Engineering (MIME) capstone design course at Oregon State University (OSU). The paper will (i)give a brief overview of the OSU MIME capstone design course, (ii)present the motivations for using GA as project advisers, (iii)discuss the benefits of using GA, (iv)examine the results of a brief case study, (v)address some of the potential issues with using graduate students, and (vi) detail the conclusions.

OSU MIME Capstone Design Course

The OSU MIME capstone design course is divided into two, ten week terms. The class typically has around 120 students that are divided into groups of three.

The first term focuses on creating a document that describes each team's design solution in detail. This term is deemed a writing intensive course to fullfill university accredidation requirements. There are three reports each group must submit, a Background Report, a Preliminary Proposal and a Final Proposal. The Background Report contains relevant information found in current literature and some of the basic Customer Reqirements. The Preliminary Proposal details a minimum of three design concepts and adds Engineering Requirements that are connected to the customer requirements using a House of Quality[5]. The Final Proposal adds a detailed description of the chosen design along with an outline of testing procedures. Each document is added to the previous document, giving students the opportunity to correct issues.

The second term focuses on implementating and testing the design created during the first term. Students are provided a budget and resources to complete the project and successfully test all engineering requirements. A Final Report is generated that includes testing results and any changes made during implementation.

Projects are sponsored by faculty, community members and industry. Since each project design was implemented, funding was necessary. For projects sponsored by industry and the community, an adviser (referred to as the project adviser) was assigned from within the university. Historically this adviser was a faculty member within MIME, however, this paper shows some of the added benefits of using Graduate Assistants rather than faculty members.

Graduate Assistant Project Advisers

The OSU MIME Capstone Design Course has used MIME faculty as project advisers. They were typically tasked with grading written reports and acting as a source for technical advice. Many faculty project advisers oversaw projects that were related to their own research, for which this model was ideal. For these types of projects the faculty member also served as a project manager and could effectively steer the projects as needed. However, when they advised industry-sponsored projects, they could no longer commit to the role of project manager, and the projects often suffered as a result

Starting in 2009, the MIME Capstone Design course began using Graduate Assistants as the project adviser for some of the industry-sponsored projects. This decision was the result of a growing capstone design program that began requiring more faculty interaction. The first GA advisers were assigned to projects that were directly related to their own research. Several graduate research assistants that had been performing research with industry partners assigned portions as capstone design projects. The GAs were then assigned to oversee the projects. This was a logical evolution of the course structure but it revealed the benefits of using GAs as project advisers.

The Graduate Assistants were given the following responsibilities:

- Grade written reports
- Act as a project manager
- Provide guidance and advisement to students
- Act as a communication hub between project sponsors, students and instructors
- Define and monitor project scope

The additional responsibilities given to the GA advisers proved to allow the industry-sponsored projects to provide higher quality deliverables.

Benefits of using Graduate Assistants as Advisers

Several benefits were realized as a result of switching from faculty to Graduate Assistants project advisers for industry-sponsored projects. Graduate Assistants tended to be more accessible to students, sponsors and instructors, they were easier to hold accountable and keep motivated, they streamlined the communication process, they were effective as project managers, and they provided accurate assessments of student performance.

Graduate Assistants tended to have a greater accessibility then faculty and project sponsors. Though graduate students were often busy, they had fewer responsibilities, giving them more free time to meet with students. Faculty are notoriously busy and difficult to schedule additional help with. It was highly beneficial for students to have an adviser that was not

only accessible but approachable. Being available to answer all manner of questions instilled a sense of confidence in the students. Many of the questions that would normally have to be answered by the project sponsor were answered by the Graduate Assistant, allowing sponsors to focus on some of the larger issues.

It was easier to keep graduate asisstants accountable and motivated for the work they performed. Because the industry-sponsored project's interests did not necessarily align with their own research, the faculty members were typically not as well suited for the project adviser role. There was no assessment of their performance and (unless they were the project sponsor) no motivation other than professional courtesy. Graduate Assistants answered to their adviser and many had a vested interest in the results of the project. They were held accountable by the project sponsor, course instructor and their own faculty adviser. Students, instructors and sponsors all benefit from having a motivated, accountable Graduate Assistant supervisor.

Communications between students, faculty, and project sponsors were funneled through the GA. One of the most effective scenarios was when there was a single, primary contact for the project sponsor. This ensured that all communications were handled appropriately on both sides, and that nothing was overlooked. Routing communications through the GA allowed the message stream to be concise, and focused, which drastically increased the effectiveness of communication. The GAs were able to filter the communications from students to the instructor or project sponsor that may have been redundant or unfocused. Having GAs on each project in the course also made coordinating different tasks by the instructor easier as there were fewer people to coordinate and the GAs schedules tended to be more flexible.

One of the key roles of the graduate student was that of project manager. In a corporate structure, company executives are typically responsible for setting out the vision for the company, and the engineering managers are used to steer the work of their employees toward that vision. Using the GAs as project managers, the project sponsors and course instructors outlined their vision for the project, and the GAs helped to guide the teams toward that vision by having regular meetings and holding reviews of their work. The more supervision and attention that was provided by the GA, the higher the Capstone Design team performed.

Graduate Assistants can also aid in the grading and evaluation of course requirements. One of the major difficulties with all Capstone Design courses is accurately assessing student performance. Because the OSU MIME Capstone Design course is a writing intensive course, there is a large amount of grading to be completed. The instructors utilized faculty members to assist in grading the extensive reports. There have been issues with the level of effort put into grading as well as the uniformity of grading between graders. The instructors have held grader workshops to help maintain uniformity between graders, but it was often difficult to get faculty members to attend. Based on the experience at OSU, graduate students are far more likely to attend intructional workshops. The grade results produced by GAs were also statistically similar to those produced by faculty project advisers which will be examined in the case study in the following section.

Case Study

It may be a concern that a Graduate Assistant will not provide the same quality of assessment as a faculty member. A case study examining grade data from the three different Capstone Design courses tested the hypothesis that GAs provide grades that are statistically the same.

A statistical hypothesis test was applied to the grades given by faculty and GA. Assuming a student's t-distribution, and a standard deviation averaged over the three year time span in question, the null hypothesis is assumed to be that there was no statistical difference between the average grade given by a faculty member versus a Graduate Assistant.

This case study considered the grades given on the Background Report, Preliminary Proposal, Final Proposal, and Final report for the MIME Capstone Senior Design course at OSU between the years of 2009 and 2011. In total, 363 reports were considered for this case study. There were 25 faculty that graded 237 reports, and 14 Graduate Assistants that graded the remaining reports.

After examining the grade data, the null hypothesis was confirmed using a 99% confidence interval. It is therefore believed that because there is no statistical difference between faculty and Graduate Assistant graders, both are capable of delivering the same quality of evaluation.

Benefits for Graduate Assistants

Though it is not the primary concern of this paper, it is important to note the benefits that Graduate A`ssistants will receive by participating in the Capstone Design course as advisers. They will gain technical experience, management experience, and grading experience.

The problems that the Capstone Design students faced were often very challenging, requiring a great deal of creative thought and technical knowledge. Guiding the students through such difficult content also strengthened the technical skills of the GA.

Managing groups of people is a skill that is usually acquired through experience and is difficult to teach. This experience allows the graduate students to gain management experience by being responsible for

managing teams of student engineers. Because many engineers go on to take a management role, this experience will benefit the GAs in their future carreers.

Using the GAs as graders also made them better graders. They were made to read very long technical reports and attend grader workshops where technical writing skills were reviewed. Not only did the experience help them to be more critical of others writing, but it improved their own writing.

Potential Issues with Using Graduate Assistants

Though the use of a Graduate Assistant has largely positive effects, there may be some negative consequencs. There will also always be variations between individuals, supervisors and departments that are difficult to account for. The main difficulties encountered with the use of GAs were the limited amount of technical expertise and professional experience. The GAs also tended to lack the level of maturity and poise that a faculty project adviser might have in the more difficult situations.

To remedy any potential issues in the MIME Capstone Design course at OSU, each GA was supported a faculty member. The faculty member was either the course instructor or their own graduate faculty adviser. Weekly meetings and additional support as needed allowed any issues with Graduate Assistants to be identified and addressed.

Another potential negative consequence may result from over-committing the GA's time. At OSU a fellowship was awarded to the graduate students as a compensation for their efforts.

The GA's faculty adviser may also take issue with their student being over-committed. This must be taken into consideration when selecting potential graduate assistants and faculty. Faculty will be more willing to volunteer their graduate students when the project has a connection to their own research (this is typically the case at OSU).

Conclusions

Using graduate students will help to reduce instructor workload, improve the performance of senior project teams and allow project sponsors to focus on the most challenging issues. Graduate Assistants tended to be more accessible to students providing more involved help to the inexperienced students and easing the burden on instructors and project sponsors. The GA were easier to hold accountable and keep motivated because they were motivated by a desire to perform. Having the Graduate Assistant serve as a communication hub allowed for streamlined communications between the instructor, project sponsor and students. Using a GA act as project manager allowed the project sponsor and course instructor to handle only the most demanding problems. The graduate students were able to provide student assessments that are accurate and reliable.

Based on the experiences and observations in the OSU MIME Capstone Design course, it is apparent that Graduate Assistants are the best choice for project advisers of industry-sponsored projects. All parties will benefit from the increased project performance.

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