INDUSTRY SUPPORTED PROJECTS – MANAGING DIFFERING EXPECTATIONS

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More than 80% of capstone projects in the William States Lee College of Engineering at the University of North Carolina at Charlotte (UNC Charlotte) are supported by companies that span a broad range of industries. Supporter size ranges from small (less than 10 employees) to large (thousands of employees) and the expectations of these supporting companies varies widely. Additionally, expectations from different employees within the same company can vary and potentially lead to a misalignment of goals between stakeholders (course instructor, faculty mentor, students and industry supporter).

A formal process has been developed at UNC Charlotte to identify the expectations of all stakeholders at the start of each project and resolve any differences. In addition procedures to execute the project are in place to verify that the expectations remain constant throughout the project. Experience has shown that when all expectations are aligned then the probability of a successful project outcome increases significantly.

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Introduction

The William States Lee College of Engineering at UNC Charlotte is marking the tenth anniversary of formally using projects supplied by outside industrial supporters in its senior capstone program. Originally there was not interaction between the stakeholders prior to the start of the project. There was no formal training or guidance provided to the industry supporters and faculty mentors. Project requirements and stakeholder expectations were vague.

As the program has grown and matured feedback from program stakeholders has been used for curriculum enhancement and to strengthen and expand employer relations. In particular, feedback provided through interviews as well as formal and informal surveys conducted over the last five years revealed important differences in stakeholder expectations. These differences resulted in stakeholder dissatisfaction on some projects which subsequently compromised corporate relationships. In some cases misaligned expectations resulted in project failure which meant that some projects were restarted with a new team. Unfortunately, in two instances an industry supporter left the program completely.

Over the last several years UNC Charlotte has developed a formal program to align the expectations of all stakeholders. The goal of this effort is to maximize the chances of project success as measured by all of the stakeholders.

Capstone Project Implementation

The UNC Charlotte College of Engineering Senior Design program is a two-semester multidisciplinary experience. Most capstone projects are externally supported by local industry[1]. The courses are structured to prepare students for their first job in engineering after graduation through a "real world" engineering project while also providing the industry supporter with tangible benefits.

On average, about 375 students participate in the Senior Design program each year. Project teams are typically composed of 5 to 6 students, although teams can consist of as few as three students and as many as 13 students. The number of students assigned to a project is dependent on the project scope and workload estimated by course instructors. Multidisciplinary (mechanical, electrical, computer, and systems disciplines) teams are encouraged but not necessary. Engineering and engineering technology majors comprise team membership. In some cases, computer science and civil engineering majors are included. Students are assigned to teams to maximize the chance of project success. Grade point average, technical skills, student preference, and previous work

experience are just some of the criteria used in the algorithm to staff teams. Each team is provided a faculty mentor and an industry technical representative. Technical expertise of the faculty mentor is desired but not required. Projects include pure design for which the deliverable is a report, computer model, or conceptual design with supporting analysis as well as design/build for which the deliverable is a functional prototype fabricated and tested by the project team.

Stakeholder Expectations – Misconceptions

Experience at UNC Charlotte indicates that most stakeholders start a project with differing expectations and misconceptions. Usually these expectations and misconceptions must be identified, discussed, and resolved before the start of the project. Expectations of the different stakeholders has been previously reported[2]. The need to have the expectations of all of the stakeholders identified has been documented.[3]

a) Industry Supporter Expectations

Occasionally an industry supporter will approach a project with the sole goal of helping prepare students for an engineering career. In such cases, the industry supporter is satisfied solely in the personal growth and education of the students throughout the execution of the project. With this philanthropic approach the industry supporter is not looking for any tangible benefit from the project. Unfortunately this perspective occurs in less than 5% of all Senior Design projects at UNC Charlotte.

The expectations of the industry supporters in the remaining 95% of the projects vary widely. The industry supporters themselves vary from very small businesses to very large international corporations such as Siemens and Duke Energy. Some of the industry supporters are startup companies and family-owned businesses. The supporters range from pure design firms to engineering and construction companies to fabrication and manufacturing companies. These differences in industries alone result in different needs and consequently different expectations. Some of these were discussed in earlier literature.[4]

Ideally, working with the same small number of industry supporters repeatedly would minimize the differences in expectations. However, most of the project supporters are not in a position to provide projects every semester. Even with those companies that provide projects every year the industry representative usually changes with every project. Also, projects may be supported by a variety of different organizations within a large company. For example, Duke Energy has supported projects related to nuclear generation facilities, fossil generation facilities, and grid modernization.

At UNC Charlotte common misconceptions of industry supporters include:

- Students provide labor at less than market rate for consulting engineering.
- Supporter involvement is not necessary once the project begins.
- Students should be able to handle scope changes throughout the project including the change of required deliverables.
- The deliverable should be a mature design and not a prototype.

Once projects have started the greatest – and most important - challenge is to keep all of the industry supporters actively engaged[5].

b) Faculty Mentor Expectations

Faculty mentors that work on several projects with the same industry supporter over a multi-semester or multi-year period generally have a good understanding of the company and their expectations. Such faculty mentors have effective partnerships with the technical representative throughout the project.

However, this situation is the exception rather than the rule despite the best of efforts of the Senior Design Committee to engage all faculty mentors that have good working relationships with local industries. As a result differences in expectations between the faculty mentor and the industry supporter persist. Examples include misunderstanding the goals or deliverables specified by industry supporter and/or initiating expanding or contracting scope changes.

c) Course Instructor Expectations

Although the course instructors are cognizant of the needs and desires of the industry supporters, their main concern is that the project satisfies all academic requirements including but not limited to student learning outcomes, ABET requirements, and quality of student work relative to the scope of the project. Generally this has not been a significant obstacle compared to misalignment of supporter and faculty expectations. The course instructors are willing to balance the requirements and expectations of all of the stakeholders.

d) Student Expectations

Student expectations vary as much as those of the industry supporters. There are often unclear and

inconsistent expectations among members of the same project team. Some students are proactive and want to impress their supporter; others just want to pass the course and graduate. Students frequently misunderstand course requirements and the potential benefits of completing a successful project. Another misalignment of expectations arises from students not recognizing the knowledge, skills, and abilities and the quantity and quality of work required to complete a project such as:

- Schedule is not important – the work can be done at the last minute.
- Communication with the industry supporter technical representative is not important.
- Minimal time is required to complete the project.
- Quality of the deliverable is not important.
- Course deliverables are more important than meeting the needs of the industry supporter.

Alignment of Expectations

UNC Charlotte has carefully considered each of the issues mentioned above and developed a process to address them. As a result, the expectations of stakeholders have been aligned, increasing the percentage of completely successful projects to over 98%. The project success rate has been measured through supporter and student surveys and feedback from the mentors. This level of satisfaction is verified through post project surveys of the stakeholders. This success rate also produces a much higher level of satisfaction for the stakeholders (supporters, mentors, and students). Some of the processes below, which have been previously documented to work well[6], were implemented.

a) Initial Project Development

The capstone projects at UNC Charlotte are developed through the Industrial Solutions Laboratory (ISL). The ISL Director is a single point of contact in the College of Engineering who interfaces with the industry supporters to develop the project. Other faculty identify projects and then hand the project off to the ISL Director.

The ISL Director initiates a conversation with the industry supporter to discuss the project. The first conversation defines the role of the supporter during the execution of the project (which is to provide regular guidance and encouragement to the team, so that important design issues can be resolved satisfactorily and promptly). The goal of this initial discussion is to provide a project description with deliverables that are agreed to, not develop the project scope.

As soon as the project is accepted and the faculty mentor identified, the faculty mentor is introduced to the supporter technical representative by the ISL Director. This initial project definition and development is considered the most important step in the design process[5]. Details that are reviewed and agreed to include:

- The ISL Director, the supporter technical representative and occasionally the faculty mentor jointly develop and agree to an overall project description and the project deliverables.
- The ISL Director, supporter technical representative and occasionally the faculty mentor agree to the design requirements.
- The Senior Design Committee determines special technical skills and abilities required of the students. These are included in the project description.
- Each technical representative reviews the Project Supporter Guide with the ISL Director.
- The ISL Director identifies and communicates the major project schedule milestones to the technical representative and the faculty mentor.

b) Faculty Mentor Engagement

Faculty mentor engagement can occasionally be straightforward such as when the mentor has regular contact with the industry supporter. In general, engaging faculty can be a challenge given their teaching, research, and service responsibilities. Some faculty are not interested in mentoring multidisciplinary projects, particularly if the scope of work can be equally split between different disciplines. In these situations two faculty mentors are required. Procedures implemented with the faculty mentors include:

- Identify the faculty mentor(s) during the initial project development.
- Involve the faculty mentor and industry technical representative in the review and refinement of the project description and deliverables.
- Explain the responsibilities of the technical representative versus the faculty member.
- Train faculty mentors at the formal Kick Off breakfast/meeting including review of the Faculty Mentor Guide document.

c) Course Instructor Expectations

Course instructors must satisfy student learning outcomes, ABET requirements, and project deliverables while also ensuring that the students, faculty mentors and industry supporters benefit from the experience. As the capstone program has evolved changes have been made:

- Senior Design Committee members regularly check with mentors within their department for potential issues that could adversely affect the project.
- Weekly meetings of the Senor Design Committee include discussion of any potential project issues.
- The grading structure was revised in the fall 2015 semester to place more emphasis on project progress and less on document submittals. This was done after feedback from mentors and supporters showed that teams could receive grades that did not reflect the actual success of the project.

d) Students – Team Formation

The Senior Design Committee is responsible for finalizing the staffing of the projects. Staffing is completed with the goal of maximizing the probability of project success. Although the students generally have little input to the selection process it is recognized that the project has a greater chance of success when the students have an interest in the project[7]. Pre-assignments are allowed upon request of the supporter or the faculty mentor. Procedures put in place for staffing include:

- Project descriptions are provided to all students via the Senior Design website.
- Students identify their top five project preferences via an online poll, and submit their resume.
- An algorithm that uses GPA, student preferences, and student skills is used to generate the first level of staffing.
- The Senior Design Committee meets to adjust the automated staffing generated by the algorithm.
- Staffing is revisited after the first semester and adjusted where necessary if successful completion of the project appears in jeopardy.

This process results in more than 90% of students being assigned to one of their top five projects. The industry supporters are very grateful to know that the students working on their project were interested in either the project, the company, or both.

e) Project Implementation

From the very beginning of the project to its completion policies and procedures have been put in place to align expectations of all stakeholders. These policies and procedures include:

- Grading emphasizes project progress during the semester, not document submittals.
- Two formal design reviews are conducted each semester; the mentor and technical representative participate in both. In the second semester these presentations are used to confirm prototype status.
- Weekly team meetings with the technical representative are required. This has been shown previously to benefit the students [4].
- Weekly/bi-weekly team meetings with the faculty mentor are required.

Conclusion

The differing expectations of the various stakeholders involved in senior capstone programs must be identified, addressed, and aligned in order for projects to be successful and to ensure stakeholder satisfaction.

The success of the industry sponsored capstone program at UNC Charlotte has been documented in two different ways. Based on stakeholder surveys, the number of unsuccessful projects decreased to zero for projects ending in fall 2015. In addition, it has been more than one year since an industry supporter decided not to participate due to dissatisfaction with the program resulting from inconsistent expectations.

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