An Examination of the Factors that Influence Students' Capstone Project Choices

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During the project selection phase in a capstone course, it is often the case that some projects are more popular than others. To understand the factors students consider when selecting a capstone project, Mechanical, Biomedical, and Electrical engineering students were surveyed. A total of 83 participants rated how important each of 14 pre-determined factors were in their recent individual project selection process. The data was analyzed to determine the relative importance of the factors. The results show that the top three most important factors are as follows: (1) obtaining engineering experience in a particular field or technical area, (2) gaining exposure to a company for employment opportunities, and (3) working on a project sponsored by industry. These results are used to identify some specific actions that can be taken to provide students with a positive educational experience in capstone courses.

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Introduction

The formation of project teams and the matching of teams and projects are challenging issues in capstone design courses[1,2]. A related question that has received much less attention is what drives student interest in particular projects. In other words, if students are given the option to rank project preferences as a part of the team and project matching process, why do they prefer certain projects? In fact, only one study could be found that addressed this question[3].

Interest in students' perception of projects was motived by the project assignment process used in the capstone engineering courses at the University of Texas at Dallas (UTD). Project assignment is done using a bid process that involves a ranking of project preferences. In reviewing the project bids, it is usually the case that some projects are very popular while others are not. This observation prompted the more general question of why students prefer some projects over others.

Anecdotal evidence suggested that students were considering factors such as exposure to a preferred employer, familiarity with the project topic, and whether the project appeared to be "easy" or "hard". In a couple of instances, students asked not to be matched with projects that involved controversial topics such as animal experimentation or military weapons systems. Beyond this, one can wonder how much peer pressure, the ability to immediately envision a solution, or perhaps some personal life experience influences project choice.

To help answer the question about why students prefer certain projects, a study was conducted to discover what factors students consider when selecting a capstone project. It is expected that a better understanding of the factors that influence project choice will help to improve the educational experience in capstone courses by enabling instructors to offer appealing projects that excite and engage students.

Background and Methodology

At UTD, two-semester engineering capstone projects are completed by students in the Mechanical, Biomedical, and Electrical engineering departments. During the first week of the semester, an entire class period is utilized to present the set of available projects to the students in each departmental capstone course. The respective instructors, or, in some cases, a sponsor representative, will explain the background, objectives, and deliverables of each project using slides that are prepared by each sponsor based on a provided template. Time is allowed for students to ask questions after each project is described. The slides and any other sponsor provided materials are also made available to the students afterward. As much as possible, all projects are presented equally (i.e., without expressing any opinion on difficulty level, workload expectations, etc.).

Following the project presentations, students are given a few days to consider their choices and submit their bids. No specific instructions or advice are provided to the class about what factors they should consider when selecting projects. Each student completes a bid form that captures various information including a ranking of project preferences. On the bid form, students can also express a preference for working with particular classmates, but it is made clear that it may not be possible

to honor all such requests. Team formation and project matching are done by individual instructors using information from the bid form and student résumés.

To gain some insight into the project selection process, data was gathered using a voluntary on-line survey that was distributed to Mechanical, Biomedical, and Electrical engineering students in the fall 2015 semester (UTD IRB Approval No. MR 15-226). The survey was sent shortly after project assignments were completed so that the project selection experience would be fresh on the minds of students. A very small fraction of students were excluded from the survey because they were on teams that proposed their own project topic. Therefore, all of the students receiving the survey had the option to pick from among the available set of industry- and faculty-sponsored projects. It did not make sense for students who worked on their own project to participate in the survey since they did not actually select a project.

The survey asked respondents to identify their engineering major, gender, and to rank the importance of each of 14 pre-determined project selection factors (listed below in the Results section). The factors on the survey were determined from the instructors' experience and perception of what considerations they believed might be important to students in the project selection process. In response to the question: "How important were each of the following factors in your project selection decision?", respondents were asked to evaluate the importance of each factor on their personal project selection process using a 5-point rating scale (Very Important, Important, Moderately Important, Of Little Importance, or Unimportant). The factors were presented to all participants in the same order and the order had no particular significance.

Valid responses were obtained from a total of 83 students. In the sample, there were 63 males and 20 females. The departmental distribution was as follows: Mechanical=27, Biomedical=26, and Electrical=30.

Results and Discussion

To create a metric for use in judging the relative importance of the 14 project selection factors, the percentage of "Very Important" and "Important" responses were summed for each of the 14 project selection factors. The rationale for this approach is that the top two ratings express a definite preference for a given factor while the other ratings show a neutral or negative response for the factor. The overall results obtained from the survey using this analysis methodology are presented in Figure 1 in rank order.

Top Ranked Factors

The survey showed that the most important consideration for students in selecting a capstone project is obtaining engineering experience. More specifically, they view the project as an opportunity to get experience in a particular field or technical area. This could mean for example that a student prefers an oil and gas industry project because that is the field they intend to enter upon graduation. It could also mean that they selected a project based on a specific personal interest such as robotics or prosthetics. In either case, it appears that students are selecting projects that align with their personal interests and goals. Students seem to recognize the importance of experience and they view their capstone project as one way of building and customizing their experience.

The second most important factor indicates that career opportunities are a major driver in student project selection decisions. The results show that students select projects sponsored by companies in hopes of gaining an internship or full-time employment with the company. It is interesting to note that student recruitment is one of the most frequently mentioned reasons companies give for wanting to sponsor a capstone project. In terms of recruitment, capstone projects are valuable to both students and sponsoring companies.

Students also place a high value on working on an industry-sponsored project. A preference for faculty-sponsored projects ranked lowest among the 14 factors. Although the survey did not probe the reasons for such preferences, consideration of the top three factors makes it reasonable to assume that students are being career-minded in making project selections. They want projects that give them experience with real-world engineering projects in their field of interest and exposure to potential employers. Employer reputation, which ranked near the middle of the 14 factors, may also reflect this same reasoning. Similar benefits of industry-sponsored projects have been noted in other studies[4,5].

Other highly ranked factors indicate that the quality of the initial in-class project introduction matters and that students give significant weight to their "comfort-level" with a project in the section process. With regard to the latter point, projects that align with students' previous knowledge and experience and students' ability to envision a solution were higher ranked factors.

Ranking of the Remaining Factors

Factors related to sponsor reputation, project requirements, and potential impact were ranked lower. It was somewhat surprising to see that students did not rate well-defined requirements and goals higher given the importance of these items in a successful project. In fact, students felt that the quality of project presentation was more important than the clarity of the requirements. Perhaps a lack of experience led students to be less concerned about project requirements and goals. The factor related to impact or value to the sponsor was included to determine if students were motivated by the

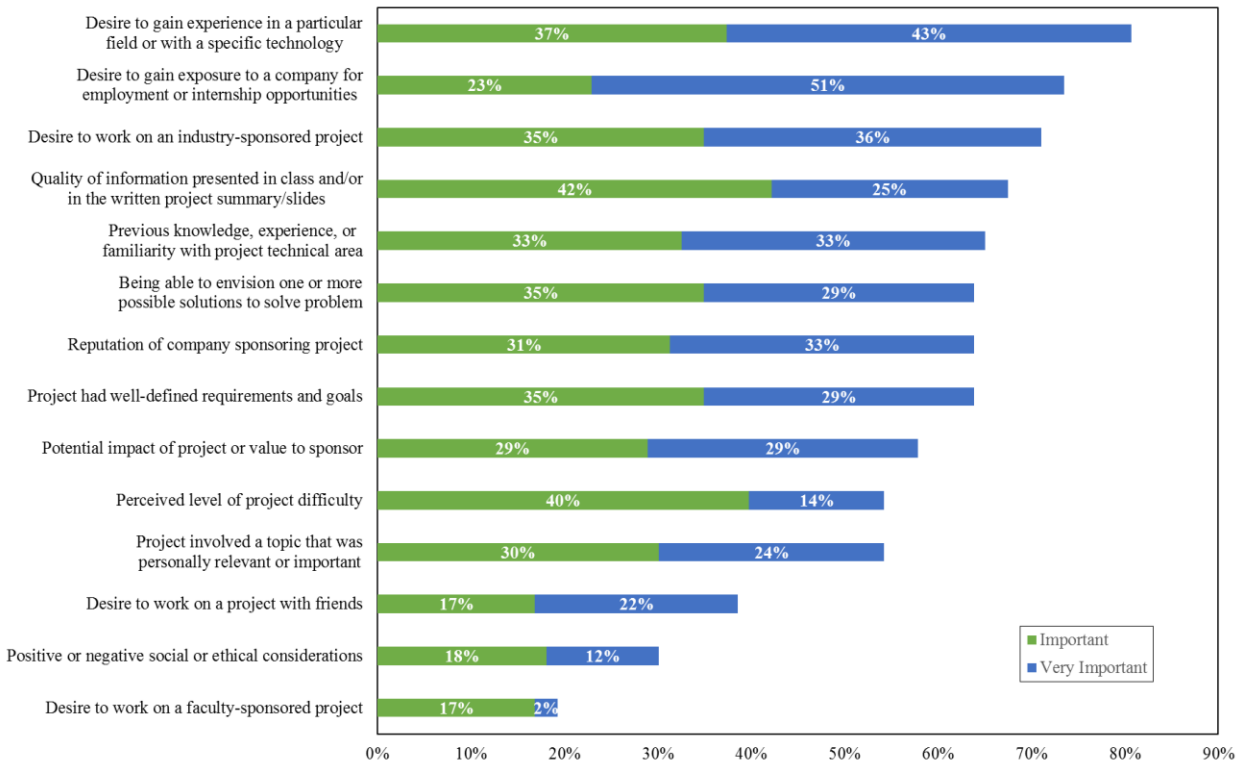

Figure 1. Percentages of the 83 survey respondents rating each project selection factor as either "Important" or "Very Important".

possibility that their project outcome could make a difference in the sponsor's work.

Previous comments from students had led to the inclusion of factors related to a project topic being something that was personally important or that a student liked or disliked from the standpoint of personal ethics or social considerations. For example, one student mentioned wanting to work on a particular project because a family member with a medical condition could be helped by the device that was to be designed. As would be expected, these factors did not have a universal appeal to students.

Lower ranked factors included perceived project difficulty and working with friends. It was expected that project difficulty would be ranked higher, but clearly students are giving consideration to many other factors and not just looking for the easiest project. This was very satisfying to see. As mentioned above, the project bid process allows students to suggest others that they would like to have on their team. If students do this, they are instructed to make sure that all the proposed team members are included on each student's bid and that all have selected the same project. The "working with friends" factor was included to see if students were changing their project preferences in order to be placed on a team with their friends. The low ranking for this factor suggests that students are either not changing their preferences or perhaps groups that want to work together already have similar project preferences.

Overall Ratings

The preceding discussion has focused on the *relative* ranking of the 14 project selection factors. Viewed from a percentage standpoint, it can be seen that more than 50% of students rated all but three factors as "Very Important" or "Important". Clearly a majority of students are considering most of these factors as they select their preferred projects. Working with friends, ethical considerations, and wanting to work on a faculty-sponsored project were the least important factors in terms of both ranking and absolute percentage.

As 11 of the 14 factors were considered to be either "Very Important" or "Important" by more than 50% of students, the data was analyzed further to determine which factors students considered "Very Important" in selecting projects. This breakdown, shown in Figure 1, revealed that only one factor (desire to gain exposure to a company for employment or internship opportunities) had more than 50% of students rating it as "Very Important". One additional factor (desire to gain experience in a particular field or with a specific technology) exceeded 40% in the "Very Important" category, while 3 others (desire to work on an industry-sponsored project; previous knowledge, experience, or

familiarity with project technical area; and reputation of company sponsoring project) were at 33% or higher. Not coincidentally these five factors were among the top-ranked factors as discussed above.

Gender and Departmental Affiliation

When the survey results were broken down by gender and departmental affiliation, there were, as would be expected, differences in the importance metric (percentage of "Very Important" and "Important" responses) between males and females and between Mechanical, Biomedical, and Electrical engineering majors for each of the 14 project selection factors. However, further analysis using the chi-square test showed that the difference for only one factor was statistically significant ($p < 0.05$). A few other cases were marginal, but only the "Desire to work on a project with friends" with $p = 0.01$ strictly met the criteria for statistical significance. For this case, the responses were 59% for Mechanical, 15% for Biomedical, and 40% for Electrical. No specific reason could be identified for why there should be a departmental difference for this factor. It is important to note that these results should be considered preliminary as some of the requirements for the expected frequencies in the chi-square test were not met by the data that was analyzed.

Implications for Capstone Courses

In light of what has been learned about the factors that motivate students when they select a project, what can be done to provide students with the best possible experience in a capstone course? Obviously, more extensive data collection is need to draw any definite conclusions, but based on the results found in this study, some preliminary recommendations are as follows:

- There is a strong preference for industry-sponsored projects. Students want both the experience and exposure offered by working with a corporate sponsor.
- Students view the capstone project as an opportunity to gain valuable experience. Ideally, a diverse range of projects should be available to the class to allow students to work on a project or in a technical area that is of interest to them.
- The quality of the initial project presentation is important. Descriptions, slides, and other materials should be carefully prepared so that students are able to get a clear understanding of what a project involves. In addition, project requirements and goals should be well-defined.
- Students tend to look for projects that match their previous knowledge and experience or projects where they can immediately see a solution. It would be good to remind students during the project section phase that they need not constrain their choices by these factors and that they will have time later to learn needed skills and develop a solution.

Conclusions

A study was performed to understand the factors students consider when selecting a capstone project. Mechanical, Biomedical, and Electrical engineering students were surveyed to determine the importance of 14 pre-determined project selection factors.

The top ranked factors suggest that students prefer industry-sponsored projects to ones offered by faculty and they view the project as an opportunity to obtain engineering experience in a particular field. Students are also using the project to gain exposure to a company for employment opportunities. Factors that ranked lower included working with friends on a project and seeking a project based on its perceived level of difficulty. Other than one factor, no statistically significant differences were found with regard to gender or departmental affiliation. Taken together, these results point to some specific actions that can be taken to provide students with a positive experience in capstone courses.

The authors would welcome the chance to expand this study to multiple institutions. We invite other capstone instructors to contact us to discuss this.

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