

Factors that Inhibit or Enable Success of Capstone Design Teams

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Engineering capstone is considered the final and crowning design course in the engineering curriculum. A typical design team is made up with three to five students and is multidisciplinary in nature. These teams are assembled either by project choice where a member is assigned to a project, or by group choice where a project is chosen by an existing self-forming group. A self-forming group is characteristically a group of friends that clumped together during their educational career. No matter how the team was formed, being part of the same team for a yearlong project creates interesting team dynamics, be it positive or negative. However, team dynamics alone is not purely indicative of a group's success or failure.

This paper looks at the individual responses of two questions asked at the end of the senior capstone experience. The first, 'Identify factors that inhibit the group in its functioning', examines how team friction, advisors, university resources, and other factors restrain the success of a capstone design team. The second question, 'Identify factors that enable the group to function well', explores the events and personalities that create a positive or success project.

Eighty-eight replies taken over two years are compared with overall grade, gender, and project type revealing factors of success and failure in senior capstone design. Overall 52.6% of all students and 95% of female students indicated that conflicts in schedule was the number one inhibiting factor in their projects success, whereas teamwork, 70.5% overall, was the leading factor in success.

1.0 Introduction

Engineering capstone design is considered the pinnacle design course of the undergraduate engineering experience. Typically, capstone design is defined by a multidisciplinary team of three to five students undertaking a yearlong open-ended project. These teams are assembled either by project choice where a member is assigned to a project, or by group choice where a project is chosen by an existing self-forming group. A self-forming group is characteristically a group of friends that clumped together during their educational career. The open-endedness nature as well as the attempt to insure a “state-of-the-art” design are some of the challenges that the design teams must overcome.

To help facilitate an understanding of the dynamics that contribute to the successfulness of the project nine questions were asked of graduating seniors at Villanova University. The responses to two of these questions, ‘Identify factors that inhibit the group in its functioning’ and ‘Identify factors that enable the group to function well’ are examined here.

Overall the responses from 88 students over a two-year period were analyzed based on project type, gender, and team performance. Since “factors” were asked for, most students gave multiple responses to each question. To assist in understanding these responses they were grouped together based on common themes and plotted on a percentage basis.

1.1 Identify Factors That Inhibit The Group in its Functioning

Table 1 – Inhibition Factors and Categories

Category	Factors
Schedule Conflict	Scheduling conflict school between and work.
Lack of Time Management	Class Work NCAA Basketball Employment Desire For Free Time Foresight
Lack of Preparation	Shop/Fabrication Inexperience Lack of Academic Background
Lack of Motivation	Laziness Lack of Motivation Low Expectations
Lack of Teamwork	Poor Communication Stubbornness, Ego Poor Organization Poor Leadership
Lack of Resources	Lack of Facilities Limited Accessibility Funding Concerns

Eighteen different inhibition factors were initially identified by the students and were grouped into six final categories as shown in Table 1. To engage the student to think about each question, no check list of factors were made available so the student volunteered each of these factors.

Note that throughout this paper figures that pertain to inhibition use the terms “Time Management”, “Preparation”, “Motivation”, “Teamwork”, and “Resources” in place of the “Lack of Time Management”, “Lack of Preparation”, and so on.

1.2 Identify Factors That Enable The Group to Function Well

Eighteen different success factors were initially identified by the students and were grouped into five final categories as shown in Table 2. To engage the student to think about each question, no check list of factors were made available so the student volunteered each of these factors.

Table 2 – Success Factors and Categories

Category	Factors
Communication	Communication, Leadership Organization, Assignments, Planning Cell phones (Texting)
Outside Assistance	Outside Assistance and Advisors Outside Funding
Teamwork	Teamwork Work Ethic, Accountability Trust and Respect Diversity of Talents Previous Team Experience (with each other)
Friendship	Friends Personality Comedy
Excitement	Excitement about Project Interesting Topic Pride Hands-on Project Out-of-box Thinking

2.0 Survey Analysis

Eighty-eight surveys were analyzed from the 2009 and 2010 mechanical engineering graduating class at Villanova University of these 50 (56.8%) respondents graduated in 2010. The gender make-up consisted of 68 (77.3%) male and 20 (22.7%) female and a total of 42 (47.7%) students were identified as high performers in the capstone design class.

Each survey was evaluated for self-assessed factors that were uniquely identified by the students as contributing to or inhibiting their success were tallied and plotted.

2.1 Overall Responses

Figure 1 shows the overall percentages for each of the six categories identified as project inhibition factors. The leading inhibiting factor was scheduling conflicts (52.6%) with many Villanova students indicating that outside of their assigned weekly group meeting they could not schedule a second common meeting time. The second and third factors, lack of time management and lack of teamwork, 46.6% and 35.2% respectively, was not a surprising result since good time management and teamwork result from group meetings. However, the surprising result was the 15.9% who indicated that lack of preparation prior to capstone design was an inhibiting factor.

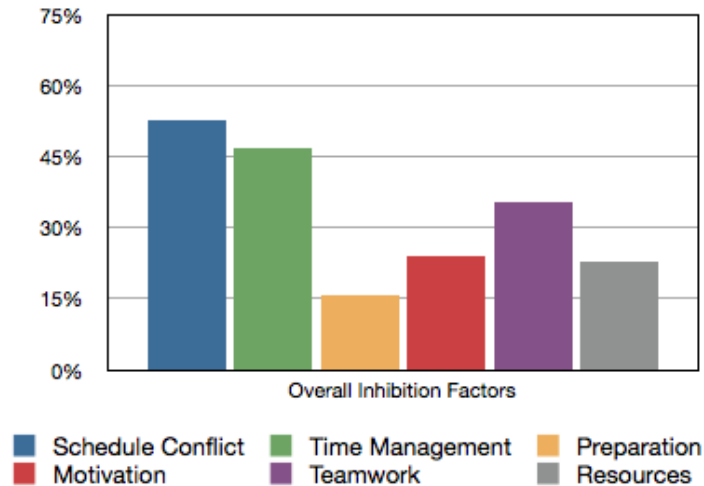


Figure 1: Inhibition Factors for All Responders

On the success side, teamwork was the major factor (70.5%) that indicated project success as shown in fig. 2. Friendship (46.6%), project excitement (34.1%), and communication (31.8%) rounded out the top four categories and like the inhibition factor of fig. 2 they are also associated with teamwork. Outside assistance was indicated in 13.6% of the surveys and will be highlighted below.

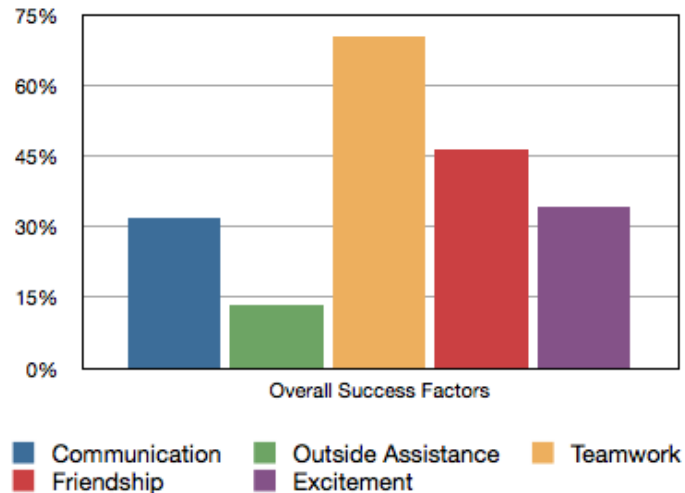


Figure 2: Success Factors for All Responders

2.1 Supported and Service Projects

Of the eighty-eight student surveys, 11 were from service-related and 18 from US Navy sponsored capstone projects. Figure 3 shows that while scheduling conflicts are still the leading inhibiting factor, the lack of resources for travel intensive service projects (63.6%) was the leading negative factor. For the more analytically demanding Navy project 27.8% indicated that lack of prior classroom preparation was no longer their least concern.

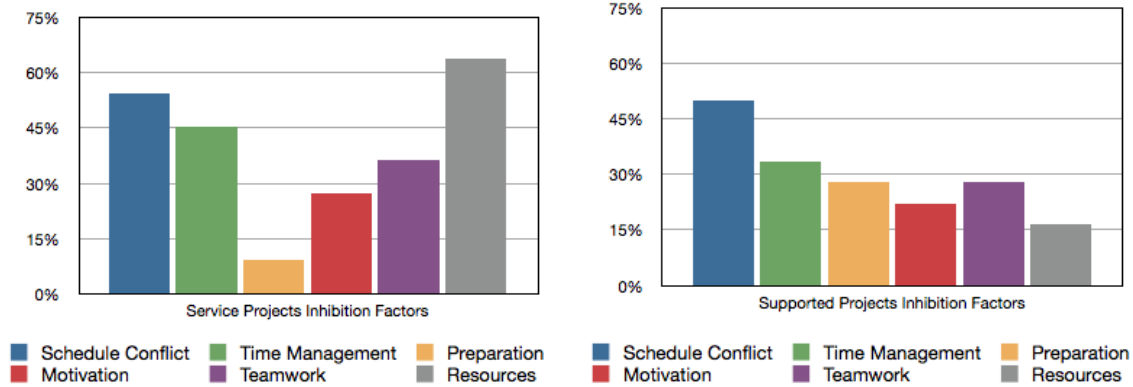


Figure 3: Inhibition Factors for Service and Supported Projects

In both service and Navy supported projects teamwork was still the leading factor but interesting, friendship and outside assistance were more important for the service projects while communication and excitement ranked as high or higher than those two categories for the Navy projects.

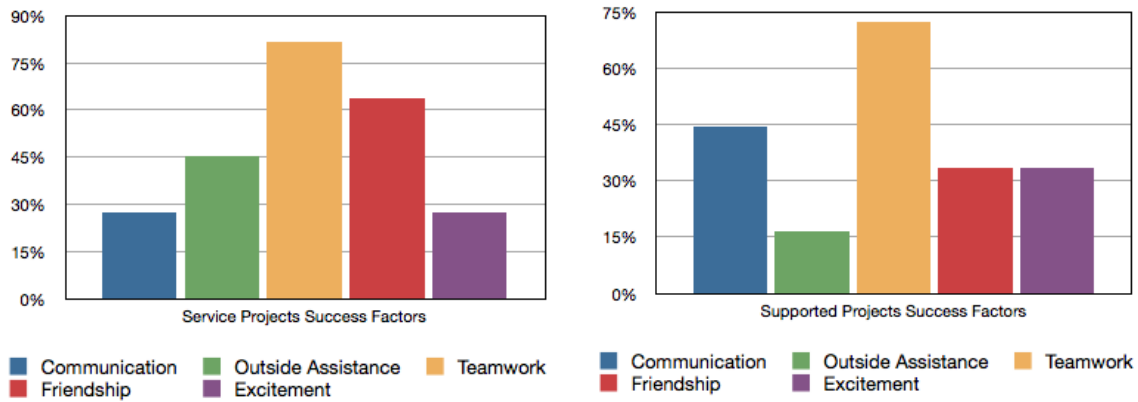


Figure 4: Success Factors of Service and Supported Projects

In comparison the 59 other “Non-supported” students show, as expected, the same trends as the entire class as shown in fig. 5.

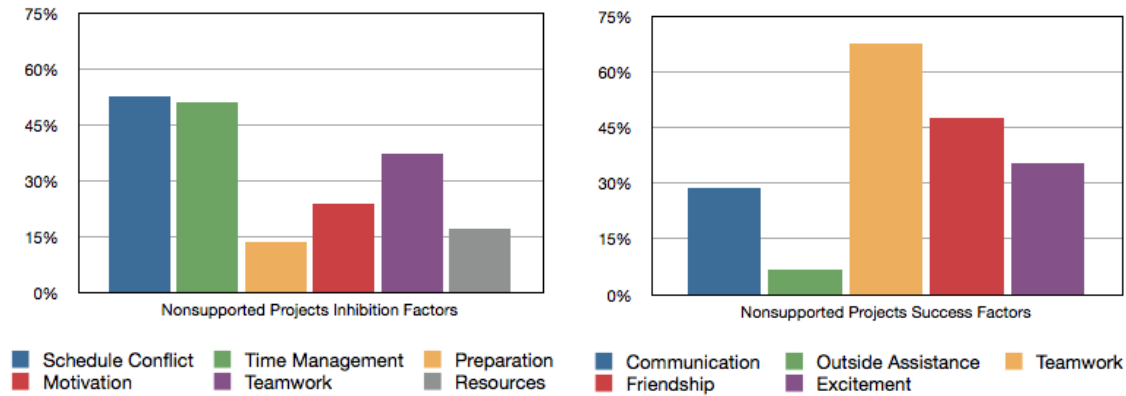


Figure 5: Inhibition and Success Factors for Non-supported Projects

2.2 Gender Comparisons

Figure 6 shows that scheduling conflicts and lack of time management are the main concerns with female students, 95% and 50%, respectively. However, for the male students these two factors only appeared on 40% and 46% of their surveys. An additional variation is that male students believe lack of preparation is more negative while the female students believe that lack of resources is.

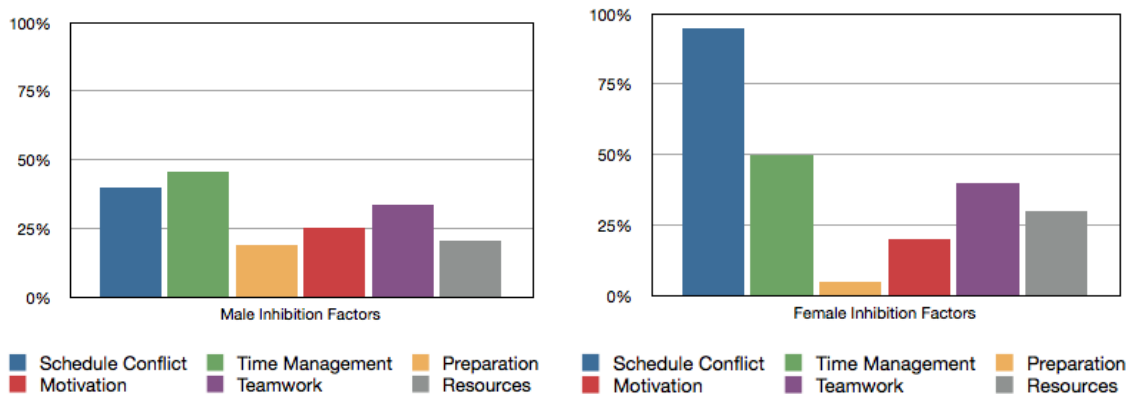


Figure 6: Gender Responder Inhibition Factors

Figure 7 indicates that teamwork, friendship, and communication are overwhelmingly the primary success factors for the female students, and while these factors are also success indicators for male students, outside assistance appears more often in the male responses. Excitement is equally represented in both genders.

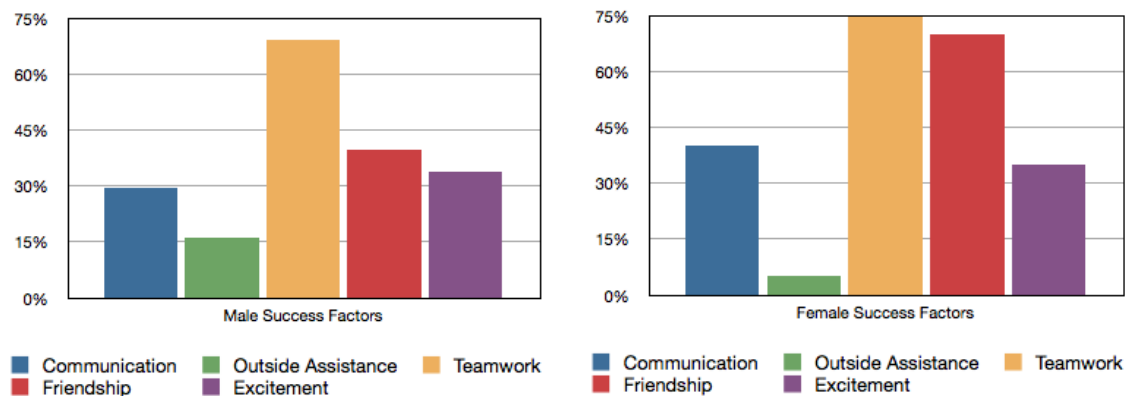


Figure 7: Gender Responder Success Factors

2.3 High v. Low Performers

While scheduling conflicts and time management were again the leader inhibition factors between high and low performers. What is interesting to note is the reversal in lack of preparations versus lack of resources as shown in fig. 8. The high performers felt they were prepared but didn't have the appropriate facilities and shop support whereas the low performers felt they weren't prepared and lack of resources was of lesser concern. The reality is that the high performers made it past the analysis stage of their design and while implementing their design discovered the lack of resources and accessibility to the existing resources. This is in contrast to the low performers who grew frustrated during the analysis phase of their project and never discovered the resource constraint. It is interesting to note that lack of motivation is a constant throughout the high and low performing groups.

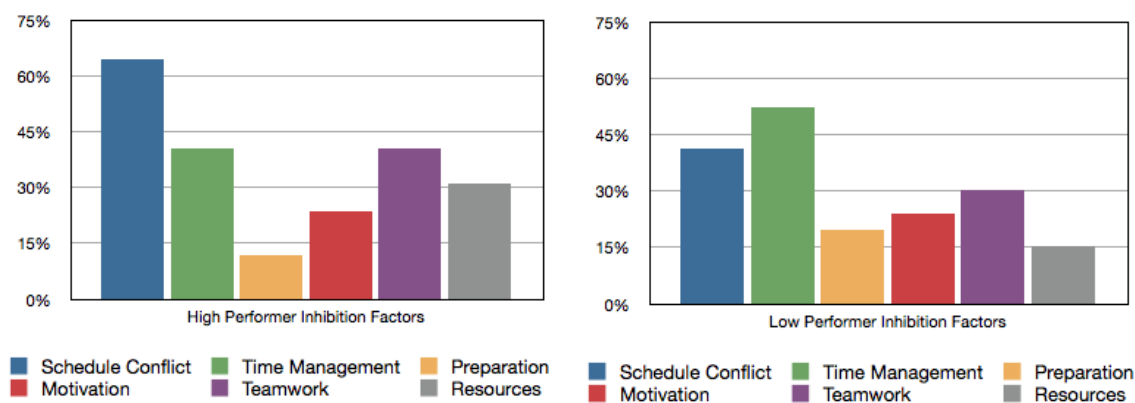


Figure 8: Inhibition Factors for High/Low Performers

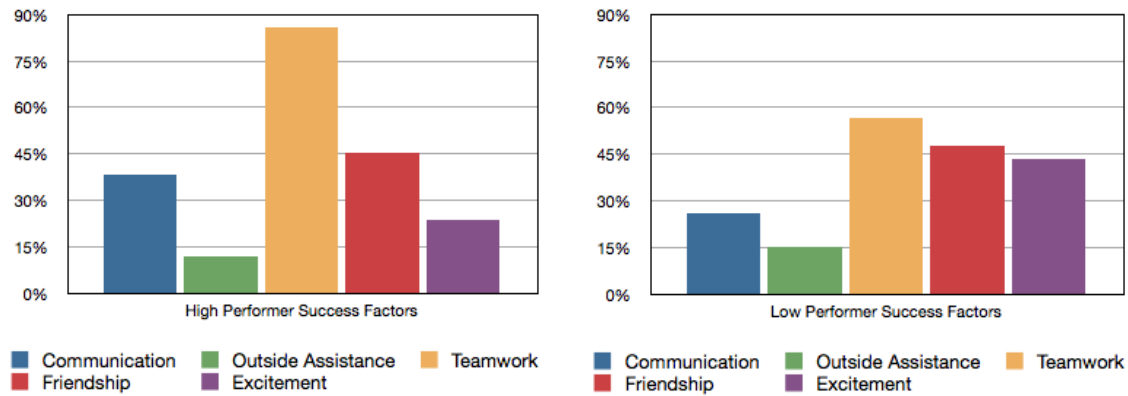


Figure 9: Success Factors for High/Low Performers

Figure 9 shows that teamwork was once again the leading positive factor in both high and low performers, however the reversal of communication and excitement indicate that the more successful high performing teams kept in contact and worked well as a team. However, from personal observation the author noted that the low performing teams used project excitement in their project to push forward success and in most cases this project excitement was a statement of individuality and as a result teamwork and communication suffered. As pointed in fig. 8, lack of motivation was always present in both high and low performing groups but the teamwork and excitement in the project prevailed enough to lead a group forward.

3.0 Conclusions

A successful mechanical engineering capstone team project relies on the obvious, teamwork, friendship, excitement, communication, and outside assistance to be successful. However, the importance of each of the factors depends on the project type, student gender, and expectations (high versus low performers). In this paper 88 students were surveyed and teamwork (70.5%) was the leading factor in the success of the project. While friendship was the second leading factor in highly technical projects it was displaced by communication.

Leading negative factors that inhibit a project success include schedule conflicts, and lack of time management, preparation, motivation, teamwork, and resources. While no solution is given on how to solve this issues it is important to note that high performing groups viewed lack of university resources as a high concern while the lower performing groups viewed lack of preparation more negative than resources. In all cases lack of motivation made its presence known.