Project Connections-Enhancing the First-Year Experience Through Freshmen-Senior Interactions

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Abstract **– While many incoming freshmen are fascinated by the field of engineering, some often have very little idea about what engineers really do. Project Connections was designed to increase the understanding of what engineers do (in particular mechanical engineers), and to highlight and emphasize the problem-solving capabilities that the incoming students can have in just four years. This was done by integrating and connecting the first year experience with the experiences of students in their final year of study. Senior students gave presentations to the freshmen classes on their Senior Design Capstone Projects. In addition, freshmen students wrote short papers highlighting the project problem, the solution, and what the senior students had to know or determine to solve the problem. The anecdotal evidence indicated that Project Connections was very beneficial to the freshmen students and rewarding to the senior students as well. Results are continuing to undergo evaluation and Project Connections is continuing to undergo modifications. The results after implementation for two semesters will be described.**

Index Terms – Freshmen-senior interaction, presentations, student engagement, Senior Design Project

INTRODUCTION

Students often enter engineering disciplines as a result of the advice of high-school counselors, teachers, family members or friends. Sometimes they have been motivated by science courses/teachers, science fair experiences, or outstanding television documentaries, but often have little understanding of what a degree in Engineering will involve or what benefits it can provide. In addition, it is not unusual for large universities to lose as many as 15% of the incoming students after the first year. This is despite the fact that grades in high school, position in the graduating class, and scores on standardized tests for the incoming freshmen are very high. In addition to a host of other reasons, some may leave engineering because they are disillusioned and feel they are not being exposed to actual engineering; at least not in the first year. There have been many initiatives aimed at engaging freshmen by providing hands-on laboratories, integrating design, integrating research, among other activities. Some of these activities have been highlighted at annual conferences devoted to engineering education in general or first-year experiences specifically (1,2).

One of the first Mechanical Engineering courses that first-year Mechanical Engineering undergraduate students often take at our institution is Introduction to Engineering, hereafter know as Intro. In addition to other learning objectives, students are typically expected to become proficient in freehand sketching, geometric modeling, and its application to computer-aided drafting and design (CADD) as a result of that course. One of the last Mechanical Engineering courses that senior Mechanical Engineering students take is the senior design capstone course, which at our institution is generally referred to as K. K is part of the Design Projects Program and in that two-part course, the students work in teams of three to four to solve a problem submitted by a sponsoring company. They typically work with a liaison from the company, as well as their instructor, a TA, and a faculty advisor to develop project-specific steps to solve the submitted problem. At the end of the semester, they are expected to give a set of deliverables to the company that sponsored the problem. K has an intensive schedule, but several milestone events include: receiving problem statements; participating in plant trips, making an oral presentation of their problem statement, making an oral presentation of their project proposal, making an oral presentation of their design reviews, making an oral presentation of their design reviews to the sponsor, and making their final presentation before an open (but sometimes closed) audience.

The schedule for K is rather full, expectations are high, and the problems are real. The skills that the students have gained over the four-year period are impressive. It would no doubt be inspiring for first-year students to be able to observe such a level of maturity and professionalism in students who are only approximately four years older than they are.

Project Connections was not meant to be a disruption to either class in any way, but rather an enlightening experience for the first-year students and a positive experience for the senior students as well. Volunteer teams from the K class gave very short presentations (approximately 12 minutes) to the Intro class. Three separate class periods for the Intro class were dedicated to Project Connections. The K students were awarded bonus points as an incentive to volunteer. The Intro students had two assignments that consisted of two papers related to the information presented by the K teams and this counted as part of their overall grade. They also responded to surveys before and after the presentations as a way of determining

how their attitudes about mechanical engineering were influenced and/or changed, and perhaps even how they had been motivated. It was expected to be a win-win experience for both classes. Moreover, it was expected to enhance the first-year experience of our students. It should be noted that the author does not teach Intro or K, but served as a facilitator for Project Connections. In addition, the pre/post survey was already a part of the existing Intro class.

METHODOLOGY

For the most part, the syllabus for the Intro class remained the same, including assignments on Reverse Engineering, Mechanical Dissection, Mathematical and Computer Modeling, Materials and Manufacturing Processes and a guest lecture from the Engineering Career Assistance Center (ECAC). However, for the fall of 2012, two activities were added; Machine Shop Activities and Project Connections. The Intro class worked in teams of at least three students per team.

Prior to the first K class meeting, the K class had been divided into teams of at least three students and there were 21 teams. The topics covered were varied and included such project titles as Design of Shape Memory Alloy Expanding and Contracting Guide, Preventive Maintenance for Offshore Valves, Design of a Veterinary Gurney, Design of Powder-Reducing Insert for Laser Sintering Machine, Analysis of Swimmer's Starting Block Jump, Design and Prototyping of Exercise Mat Cleaning Machine, Design of Housing Installation Process for Downhole Tool, Accelerated Life Testing of Polymeric Materials, Selection of Fire-Proofing Material for Petroleum Piping, Design of Intake System for a Racecar, Specification of Miniature Natural Gas Engine for Unmanned Vehicle, and Redesign of Commercial Waste Container.

The remainder of the paper will focus on Project Connections. Three class periods out of the semester were allotted for the Intro class and there were two sections of the class, with about 90 students per section. To aid in assessing the benefits of the project, two surveys were given; one prior to the beginning of the project presentations and one after the conclusion of the final project presentation. The pre/post surveys focused on their perception of mechanical engineers and specifically on What Mechanical Engineers Do. An example of the survey is shown in Table I, and the responses could range from 1, Strongly Disagree to 5, Strongly Agree. It should be noted that these surveys were not unique to the Project Connections portion of the course, but were used for most of the Intro activities.

TABLE 1
WHAT MECHANICAL ENGINEERS DO" SURVEY

"What Mechanical Engineers Do" Survey
ME 302

Name _____

The following questionnaire lists some common impressions of "What Mechanical Engineers Do." For each activity listed, circle the number that best agrees with your current impressions of Mechanical Engineering. In the survey, **ME** can mean Mechanical Engineering (as in profession) or Mechanical Engineers (as in persons).

WHAT THEY DO	STRONGLY DISAGREE	DISAGREE	NEUTRAL	AGREE	STRONGLY AGREE
1. ME use math and science to solve problems	1	2	3	4	5
2. ME work with hands-on projects	1	2	3	4	5
3. ME work on car engines and other machines	1	2	3	4	5
4. ME salary is good, and you can rise to management and leadership positions	1	2	3	4	5
5. ME work with fluid and thermal systems	1	2	3	4	5
6. ME apply engineering to social problems	1	2	3	4	5
7. ME design products and build systems	1	2	3	4	5
8. ME is a rigorous educational experience	1	2	3	4	5
9. ME work to improve the living standards and safety of humans	1	2	3	4	5
10. ME work in homeland and cyber security	1	2	3	4	5
11. ME work to make a sustainable world and help the environment	1	2	3	4	5
12. ME work with solar, wind and other alternative energy sources	1	2	3	4	5
13. ME is a good degree for starting a small business or enterprise	1	2	3	4	5
14. ME conduct experiments and take data	1	2	3	4	5
15. ME is a fun career with lots of choices	1	2	3	4	5
16. ME like to work in teams	1	2	3	4	5
17. ME use computers and software	1	2	3	4	5
18. ME select the materials used for products	1	2	3	4	5
19. The ME profession runs in my family	1	2	3	4	5
20. ME is the "new college degree" for the 21st century	1	2	3	4	5

During the first class period, which took place near the beginning of the semester, there were four presentations from the K teams. The team members essentially described their project as they perceived it at that time and discussed how they planned to go about solving the problem. During the second class period which took place during the middle of the semester, there was an open forum in which the students were presented with a summary of team projects they had not heard, as well as an overview of the ME curriculum flow chart and how the information learned in specific courses might be helpful in solving some of the problems. During the third class period, which took place near the end of the semester, students heard the final presentation from one K team; a team they had heard before. This was the final presentation that the K students were planning to present in their class.

In Assignment 1, the teams were to describe three of the four presentations they heard in a one-page paper. They were to include a response to the question (What do mechanical engineers do?) based on what they had heard.

In Assignment 2, the teams were to describe the problem and the K-team solution based on the final presentation of the K team. The team paper was to be between two and three pages. In it, they were to include what the mechanical engineers needed to know and do to solve the problem. The team could also include comments and suggestions. Bonus points were given for suggestions for Project Connections.

RESULTS, WORKS-IN-PROGRESS, AND CONCLUSIONS

Since this was a new and very different project, it was not clear how it might be received. However, the response was overwhelmingly positive. Intro students were hesitant to ask questions at first, but quickly responded with very little prompting once an initial question was asked. Moreover, by

the second and third class periods, they were very comfortable asking questions and even providing suggestions

The Intro team papers were interesting and insightful. Some of the students requested to see some of the PowerPoint slides again so they could take additional notes. In both assignments, there were recurring themes such as the importance of teamwork, creativity, innovation, problem solving, optimization, improving on ideas, improving product design, and perhaps most importantly the use of fundamentals in physics, math and engineering in solving problems. It is noteworthy that the students felt that Mechanical Engineering is one of the broadest engineering disciplines. In fact, a few commented that mechanical engineers could do almost everything.

A comparison of the pre and post surveys is shown in Table 2. While the differences are not as striking as the anecdotal evidence might suggest, several responses are quite interesting; responses from questions 3, 6, 10, 13 and 20. Probably 20 years ago, question 3 would have received a pre-score of almost 5. Now students are aware of the fact that the work of mechanical engineers is not limited to automobiles. The breadth of mechanical engineering was also evident in the awareness of the diversity in mechanical engineering based on questions 6, 10, and 13 and the recent popularity of mechanical engineering was demonstrated in the responses to question 20.

The responses to question 19 were rather confusing. It does not seem realistic that the responses would have changed so much. However, it is possible that the students were identifying themselves more strongly with engineering in the post-survey. The results still seem unclear.

Project Connections was continued during the spring of 2013. There were 28 K teams and only two class periods were allotted for Project Connections. One of the additional goals for Project Connections was to develop a metric that was perhaps more definitive and explicit in capturing the benefits of the freshmen-senior interactions. To that end, Assignment 2 was modified and contained a group and an individual part, with the individual part being more open-ended. The questions asked in the individual part of the assignment are included in Table 3; these questions were worth 30 of the total 50 points for the assignment.

The results are currently being analyzed. Since they are individual and open-ended, they are more difficult to evaluate. However, preliminary results, in response to question 11 on the individual part, indicate that over 95% felt that Project Connections was beneficial to them. They could envision themselves as seniors and had a better idea of the types of problems they would be capable of solving, and how the curriculum supported that development. Many of the students wanted more interaction with the K teams. Some students even wanted to work with the teams, as well as get more detailed information on the day-to-day activities that led to the solution of the problem. It is clear that the open-ended questions will provide more useful information regarding the impact of Project Connections. Ongoing information will also be obtained from subsequent discussions with students who participated in Project Connections. It is being continued in the 2013-2014 school year with implementation of some of the suggestions the students provided.

TABLE 2
WHAT ME DO SURVEY RESULTS (RAW DATA)

What ME Do Survey Results in ME 302 for Fall 2012

A. Raw Data

What ME Do ?	Pre	Post	Gain	Pre-Post Average
1. ME use math and science to solve problems	4.698	4.750	0.052	4.724
2. ME work with hands-on projects	4.459	4.654	0.194	4.556
3. ME work on car engines and other machines	3.962	4.314	0.351	4.138
4. ME salary is good, and you can rise to management and leadership positions	4.377	4.588	0.211	4.483
5. ME work with fluid and thermal systems	4.151	4.497	0.346	4.324
6. ME apply engineering to social problems	3.959	4.386	0.427	4.172
7. ME design products and build systems	4.478	4.575	0.097	4.527
8. ME is a rigorous educational experience	4.447	4.654	0.207	4.550
9. ME work to improve the living standards and safety of humans	4.365	4.582	0.217	4.473
10. ME work in homeland and cyber security	3.472	3.993	0.522	3.733
11. ME work to make a sustainable world and help the environment	4.032	4.261	0.230	4.147
12. ME work with solar, wind and other alternative energy sources	4.050	4.332	0.282	4.191
13. ME is a good degree for starting a small business or enterprise	3.547	3.993	0.446	3.770
14. ME conduct experiments and take data	4.006	4.366	0.360	4.186
15. ME is a fun career with lots of choices	4.403	4.464	0.062	4.433
16. ME like to work in teams	4.314	4.451	0.137	4.383
17. ME use computers and software	4.440	4.510	0.070	4.475
18. ME select the materials used for products	4.126	4.444	0.319	4.285
19. The ME profession runs in my family	2.277	2.647	0.370	2.462
20. ME is the "new college degree" for the 21st century	3.176	3.621	0.445	3.399

TABLE 3
INDIVIDUAL PART OF ASSIGNMENT 2 FOR SPRING 2013

Survey

6. What factor(s) caused you to choose Mechanical Engineering as a major?

7. So far, is the curriculum turning out to be what you thought it would be? If yes, in what way? If not, what is different from your expectations?

8. Are you involved in a Freshman Interest Group (FIG)? If so, which one? If not, did you consider applying to be in one?

9. Have you become involved in any engineering student organizations? If so, which one (s)? If not, which organizations are you aware of (eg ASME)? If you did not become involved in an engineering student organization, is there a reason that you chose not to get involved in one?

10. Since coming to UT, have you gotten to know students who are in their second year (or higher) in Mechanical Engineering? If so, how have these students influenced your perception of Mechanical Engineering?

11. Has Project Connections been helpful in your understanding of what is involved in Mechanical Engineering? If so, in what way?

12. In what way(s) could Project Connections be improved?

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