

2006-11: INTRODUCING ENGINEERING MANAGEMENT TO HIGH SCHOOL STUDENTS

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Introducing Engineering Management to High School Students

Introduction

Attracting students to Engineering Management as a major and as a career field has always been challenging. One aspect of the problem is the difficulty in explaining to students in simple and clear terms just what Engineering Management is. Despite its well known reputation, including its place as the founding department in the field and being ABET accredited, it is unusual for an incoming freshman student at the University of Missouri – Rolla (UMR) to have much understanding of the Engineering Management and Systems Engineering (EMSE) Department or its Engineering Management undergraduate major. The other key aspect of the problem is the general decline in interest in Engineering. Yankelovich¹ reports that in Japan, 66% of undergraduate students receive engineering or science degrees, and that number in China is 59%. That compares to only 32% in the U.S. When the science component is stripped out of those figures, the numbers are even more dismal. As Barrett² indicates, less than 5% of U.S. students receive engineering degrees as compared to 65% in China and 29% in Japan. Overall, Asian countries produce eight times as many bachelor's degrees in engineering as the U.S.³ As Friedman⁴ describes the problem, "In China today, Bill Gates is Britney Spears. In America today, Britney Spears is Britney Spears – and that is our problem." This growing vulnerability is seen as a key trend in higher education that must be effectively addressed if the U.S. is to maintain its world leadership in technology. Yankelovich, Barrett, and Friedman all point out this vulnerability and its negative impact on the future of the U.S.

At UMR an attempt is being made to address this problem through a summer program for high school students in which the Engineering Management and Systems Engineering (EMSE) Department has been an active participant. High school juniors and seniors participate in the week long Jackling Introduction to Engineering Program⁵ every summer. This camp is held for three, one week sessions during the months of June and July. The purpose of the program is to introduce engineering disciplines to high school students to aid them in their choice of study for their college career of which they are soon to embark. While the department has been active in the program for several years, until now no attempt has been made to study the impact of this program on the level of understanding of the participants of the field of Engineering Management or the impact of this summer program on their decision to pursue a degree in this field.

When the visiting high school students come to the department, they are given a tour of the building, including the computer learning centers and the Integrated Systems Facility Laboratory which houses numerous pieces of equipment to aid in design of lean and flexible manufacturing systems. During the students' visit, they are also asked to compete in two simulations that are used to simulate decision making and job functions that are common for graduates of the EMSE department.

Student Activities

In the short sessions available to the department during each week of the program, a decision had to be made about which concepts related to Engineering Management would be emphasized during the student activities. Obviously, the full breadth of important concepts could not be included, so a balance between the concepts covered and engaging activities had to be struck. A decision was made to structure the activities around technical product management concepts by choosing “products” to which the high student could relate. Two product simulations were chosen. The first involved the marketing and production of a Palmtop type product, and the second covered the production of a car in a “Monster Garage” scenario to serve a target market. These two activities would expose the students to the concepts of teamwork, decision making, and typical product management activities such as planning, marketing, logistics, and production.

The Palmtop, Inc. Simulation was crafted by the EMSE department for the Introduction to Engineering program. The goal of this simulation is to enable the students to experience decision making in an uncertain business environment and to shed light on the job functions that EMSE graduates often execute. This simulation is run for approximately 60 minutes and does not require specific knowledge of technical or business areas. The students are asked to divide themselves into teams of two to four people per team. After the teams are formed, the students are presented with a small handout that explains the rules of the simulation. The students are also asked to listen to a short PowerPoint presentation as to the nature and rules of the simulation and their objectives as a team for the simulation. The objective of this simulation is provide effective decision making regarding issues of market research, product design, efficiency and ultimately to obtain maximum profit after doing so.

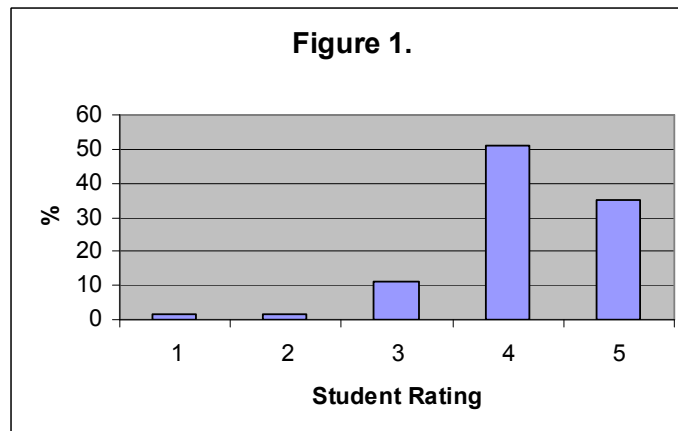
At the beginning of the simulation, the teams are instructed that they will be in charge of the production of Palmtops, which are small, handheld computers. The teams are given the option to purchase market study information and manufacturing study information which could reveal market demands and manufacturing tips for accuracy and efficiency. The teams are then instructed to determine how much money they should invest in various areas of manufacturing to produce a marketable, desirable handheld Palmtop. They must make decisions on how much money to invest in areas such as cost reduction, additional features, artistic design, and reliability. They must also decide whether to produce Palmtops in mass quantity or invest in precise robotic workstations. After all of these decisions have been made, the teams must then determine the selling price of their Palmtop. Profits are calculated based on market and manufacturing demands and how well the teams captured those demands into their manufacturing design in the simulation. The team that obtains the highest profit level after two simulated years of decision making wins the simulation. Finally, the simulation is brought to a close by a discussion of how an EMSE degree is valuable to students to educate them in the areas of engineering and business that the students just encountered.

During the course of the students' visit, they are also asked to compete in a simulation designed to illustrate decision-making regarding manufacturing, management, logistics, project management, marketing and scheduling. The students were split into teams of approximately 3-5 people per team. They were instructed as to the objectives and rules of the simulation via a short PowerPoint presentation. The teams were to assign individuals from their team to the following job titles: logistics coordinator, quality control supervisor, finance director, project manager, manufacturing engineering supervisor, and a marketing team. Each member was given a description of the tasks that their assigned position was to carry out.

This simulation was carried out in the form of assembling a model car, "Monster Garage" style. Numerous model cars were purchased; their parts were cut apart and then mixed up in boxes and displayed as a "junk yard" for the teams to shop from. The teams were also given a budget to purchase parts for their car assembly. Criteria were set as to what parts of the car were required to be in tact to qualify for judging. Specification sheets (instructions for assembling the model car) were also offered to the teams for a minimal fee. The teams were encouraged to improvise and "customize parts" if they couldn't find the correct part for their car. The objective of the simulation was for the teams to determine their target market, assemble a car to meet their target market needs, do benefit cost analyses to determine how to most efficiently and economically meet their market demands and to also produce a quality product under given time constraints. The simulation came to a close by discussing with the students how EMSE graduates must be able to overcome obstacles, be creative, deal with all types of projects and people, work together, and perhaps most importantly, be flexible.

Student Feedback

There were two forms of student feedback directly pertinent to the undergraduate program. The first was a feedback form given to each student right after attending the EMSE department sessions. The students were asked to rate their interest in Engineering Management as a result of their experience. Over the three weeks there were 65 responses with the results shown in Figure 1. The response ranges were from 1 = *no interest* to 5 = *very interested*.

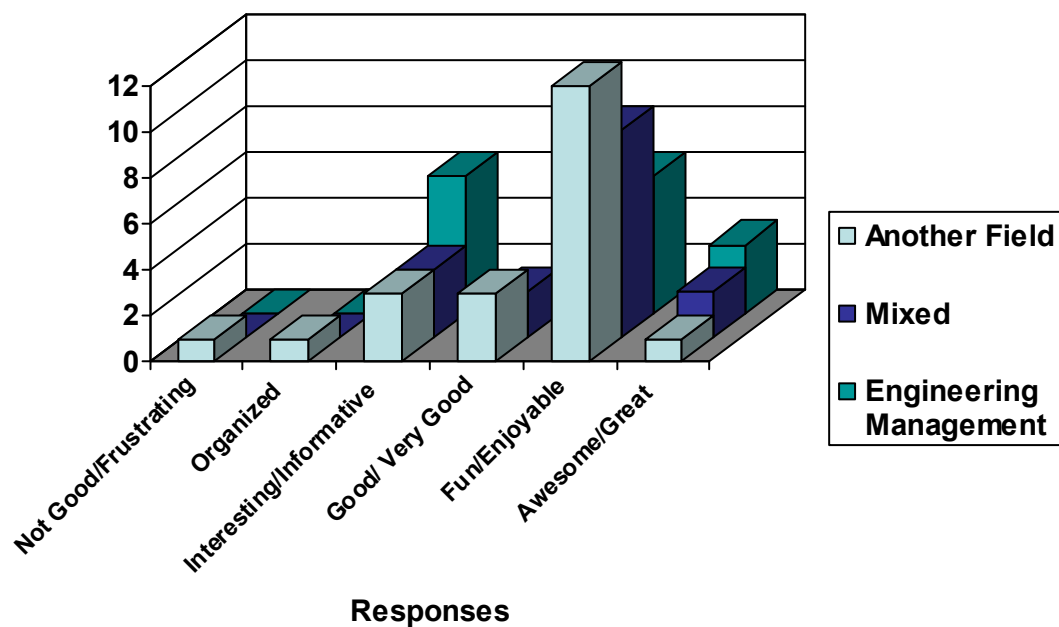


The second form of feedback occurred as part of the exit survey conducted by the Director of the Jackling Program. There were both comments and career interest information collected. For this paper, the students' descriptions of the department simulations were correlated with their indicated career choice. Table 1 shows the different ways respondents described the department simulations using categories developed from the respondents' own words.

Table 1. Students' Description of Simulations	# of Respondents
<i>Awesome/Great</i>	6
<i>Fun/Enjoyable</i>	27
<i>Very Good/Good</i>	5
<i>Interesting/Informative</i>	12
<i>Organized</i>	1
<i>Not Good/Frustrating</i>	1

Figure 2 correlates the students' descriptions with their indication of potential career interest. The category of *Another Field* encompasses the responses of those students who did not indicate Engineering Management as a career interest, *Mixed* encompasses the responses of those students who indicated Engineering Management along with another career interest, and *Engineering Management* encompasses the responses of those students who indicated only Engineering Management as a career interest.

Figure 2 Field Interest Vs. Activity Response



Conclusions

As far as creating interest in Engineering Management, the Jackling Program appears to have had a very positive impact. 86% of the students indicated that they were interested or very interested in this subject and/or department after completing the department level activities. Individual written comments on the feedback form suggest a much improved understanding of the focus of the department and engineering. Several comments are worth noting:

The games helped give me a feel of what the field is like.

Played a game that introduced us to the department

...before coming to Jackling I didn't know what many types of engineers did.

They (the exercises) gave us a good idea of exactly what the department is dealing with and what we would be learning about.

Engineering Management used contests to accurately portray real life situations in the field.

These responses show the power of the hands-on activities. Over 70% of the respondents rated the activities in the range from *good* to *great*. This is an indicator that an orientation program for high school students can produce effective results by including experiential learning. The impact of the student activities on the selection of a career field was not as dramatic for Engineering Management. 29% of the students who gave a *good* to *great* rating of the activities indicated Engineering Management as their career field choice. However, it is likely that few of these students would have indicated an interest or knowledge of the field prior to this summer program.

Relative to increasing overall interest in engineering, the Jackling program is fulfilling its mission. Of the 52 student responses to the exit survey only three indicated a career choice other than engineering after completing the program. Still, the student activities in Engineering Management can be improved. Observations of the students engaged in the activities suggest that a better job can be done in explaining the activities up front so the students appreciate why the particular simulations were chosen. Clearer explanations and instructions will be given in future simulations, and some debriefing time will be given to the teams at the end of the simulations, before they disband, to allow them to articulate what they see as their group learning.

The EMSE department will continue to participate in the Jackling Program. For follow-up, the department will begin tracking the number of new students choosing Engineering Management as a major who were participants in this program in a prior year. This will serve as a very good measure of the impact of the Jackling Program on enrollment in

Engineering Management., and allow us to adjust and enhance the program as time goes on

Bibliography

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