First Year Engineering at a Virginia Polytechnic Institute and State University: A Changing Approach

Jeffrey B. Connor, J. C. Malzahn Kampe
Virginia Polytechnic Institute and State University

Over the past 50 years, engineering education has undergone a shift from an emphasis of experimental and hands-on learning to theoretical, lecture based instruction. The engineering education community is nearing consensus that the pendulum has swung too far. Our students and the industries we serve make the need for change clear, and Virginia Tech's College of Engineering is implementing new methods of instruction. More specifically, the first year engineering program at Virginia Tech is in the process of undergoing significant modification in both our approach and emphasis in educating our students.

This paper discusses the past, present, and future efforts of Virginia Tech's Engineering Fundamentals Division in implementing these changes. First, a brief background of our recent endeavors to provide hands-on and early design activities is presented. A snapshot of our current programs detailing lessons learned and successes follows, and the final section discusses the short to medium range goals of the Engineering Fundamental Division.

Introduction

At Virginia Tech, all first-year engineering students are admitted as general engineering students, and they select a major at the end of the freshman year. The first year curriculum is essentially identical for all students and the Division of Engineering Fundamentals serves as their home. The Division's 13 faculty teach the two first-year engineering classes (EF1015 and EF1016) and a variety of sophomore level programming and graphics classes. EF1015 and EF1016 are both 2 credit hour courses typically offered in the fall and spring, respectively. In addition to teaching, EF faculty are the advisors of the 1200+ first year students.

Background

Until the fall of 2001, EF1015 topics included ethics, the engineering profession, problem solving, programming with MatLab, statics; material balance; electricity; and energy. Traditional EF1016 topics were design theory, graphics theory, freehand sketching, computer graphics using AutoDesk's Mechanical Desktop, and a final design project. Both courses were taught in a 32 seat classroom with an instructor's computer and 16 monitors. A combination of PowerPoint slides, overhead transparencies, and a conventional blackboard was used - essentially a traditional lecture format.

A pilot program[1] was conducted in the fall of 2000 to assess the efficacy of providing a number of hands-on activities. Two instructors and 240 students participated in the fall of 2000 and the results were positive. When compared with students in a traditional setting, the pilot program students were significantly more excited about engineering and their perception of learning was

significantly greater.[2] The activities were designed to be conducted within the normal lecture time and, hence, of short duration (15 minutes), illustrative of the current topic of instruction, and inexpensive. Another major goal of the project was to have the students work in teams. Typically data was team collected in class with the calculation of results and study questions assigned as homework.

As an example, one project was to take all measurements necessary to determine the density, surface area, precision of manufacture, and description of a somewhat geometrically complex wood block. The tools available were a simple postal scale and a 12-inch ruler. Given early in the semester, this activity is meant to give students an appreciation for precision, units, conversions, and sketching.

For the past 3 years a hands-on component has been used in the EF1016 course. Each student spends one evening during the semester engaged in a hands-on activity related to print reading and measurement. EF 1016 is an engineering graphics course and this exercise is an opportunity to put a real object in the students' hands along with an engineering drawing of that same object.

Fall 2001

In the fall of 2001, the in-class hands-on activities were expanded to include all 38 sections of EF1015. In order to accommodate this formal alteration of the course, the traditional topics of electricity and statics were dropped and replaced with data analysis and a somewhat expanded hands-on component. Table 1 is a list of activities performed in that semester.[3]

Table 1
Fall 2001 Activities

Activity	Title	Lesson	Kit Items
1	Pullback & Friction Car	1	Pullback Cars
2	Fatigue Data Gathering	3	Large Paper Clip
3	Pool Noodle Surface Area	3	Pool Noodle
4	Density	5	Block, spring scale, ruler
5	Data & Graphing	11	Clock
6	Archimedes' Principle	26	Water container, block, ruler
7	Material Balance	27	Screen, gravel, sand, spring scale
8	Forces	28	Spring scales, weights

In an attempt to provide an opportunity for the students to work on more open-ended problems, "MacGyver boxes" were piloted in 11 sections of EF1015. Each of the 340 participating students was assigned to a team of four, and each team was given a box containing a few simple tools and miscellaneous gears, fasteners, wood, and other potential project components. Over the course of the semester, the groups were assigned three projects to build and test: bridge, car, and ping-pong ball launcher. The assignments were tightly structured with specific performance

goals. All 22 groups were brought together at the completion of each project to be graded for performance. Written work supporting the design was also submitted and graded as homework.

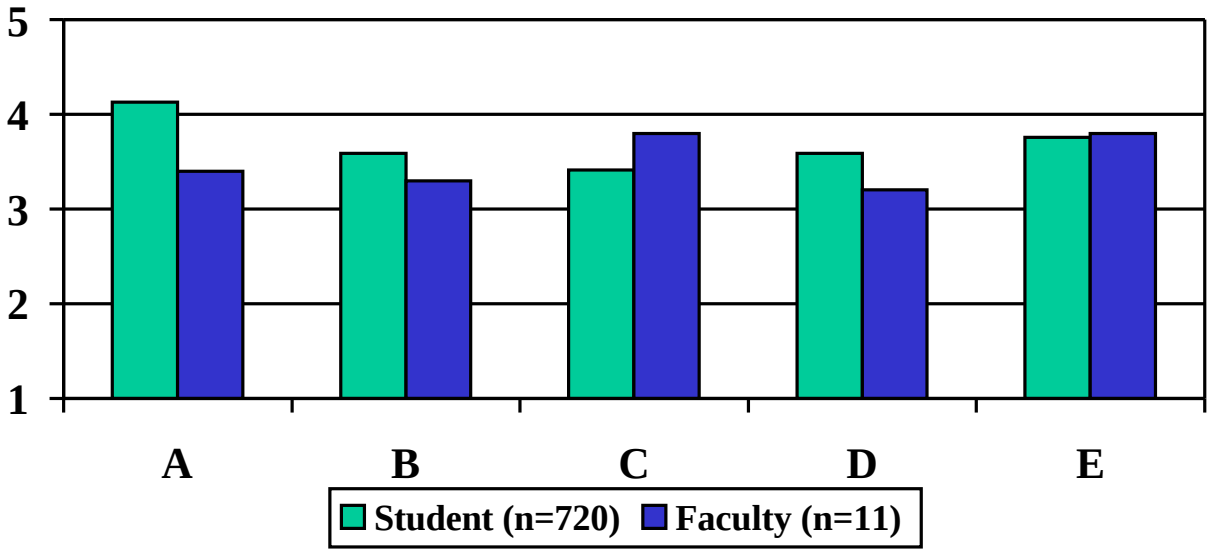
Lessons Learned

Incomplete assessment of the fall 2001 course indicates that, in general, the use of hands-on projects was positive. 720 students and 11 faculty responded to a survey of their impressions of the course. They responded to the following statements where 1 indicates strongly disagreeing, 3 is neutral, and 5 is strongly agreeing:

A. The course is challenging (to the student)
B. The course is an appropriate introduction to engineering
C. The projects enhanced learning
D. The projects are at an appropriate level
E. The use of teams enhanced learning.

The mean results are presented in Figure 1 below

Figure 1
Fall 2001 Responses



Students participating in the MacGyver boxes were also generally positive. A poll was conducted and preliminary results indicate that the greatest benefit, again, was the team aspect. A number of comments indicate that working with and meeting new people was the best part of the project and that many friendships resulted. One difficulty with the projects was to find ones that were challenging yet within the abilities of a first year student.

The more the courses change, the greater our need for custom texts. In the fall of 1999 we used a custom printing of portions of two McGraw-Hill texts, *Introduction to Engineering* by Eide et al and *Foundations of Engineering* by Holtzapple and Reece. In addition, Dr. Kampe provided a modular lesson in flowcharting that was integrated with the McGraw-Hill texts. In the years that followed, Kampe has continued to add in-house modules as supplementary material to our text. It appears that this trend in will continue.

Beyond Spring 2002

Major, but incremental, change will undoubtedly continue for the foreseeable future. It seems certain that EF1015 and EF1016 will evolve into something new that is a meld of the two over a full year rather than two distinct courses with two distinct set of topics.

Bibliography

[1] R. M. Goff and J. B. Connor, "Hands-On Experiences in the Freshman Engineering Classroom" in *2001 ASEE Annual Conference & Exposition* (Albuquerque, NM, ASEE, 2001)

[2] J. B. Connor and R. M. Goff, "Assessment of Providing In-Class, Hands-On, Activities to Virginia Tech's First Year Engineering Students" in *2001 ASEE Annual Conference & Exposition* (Albuquerque, NM, ASEE, 2001)

[3.] R. M. Goff and J. B. Connor, "Early Design Experiences in the First Year Engineering Classroom" in *2002 ASEE EDGD mid-year Conference* (Berkeley, CA, ASEE, 2002)

JEFFREY B. CONNOR is an assistant professor in the Division of Engineering Fundamentals at Virginia Polytechnic Institute and State University. He received his M.S. degree in civil engineering from VPI&SU and B.S. degree in civil engineering from the University of Lowell and is currently pursing a Ph.D. in civil engineering from VPI&SU where he teaches freshman engineering.

J. C. MALZAHN KAMPE is an assistant professor in the Division of Engineering Fundamentals at Virginia Polytechnic Institute and State University. She received her Ph.D. in metallurgical engineering from Michigan Technological University, M.Ch.E. in chemical engineering from the University of Delaware, and a B.S. degree in chemical engineering at Michigan Technological University.