FOUNDATIONS OF ENGINEERING-A FIRST YEAR COURSE

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ABSTRACT

The University of Rhode Island College of Engineering has introduced a common freshman course after doing without one for more than twenty years. In addition to trying to help students find out about engineering, other key issues were retention, recruitment and diversity. This freshman course also allowed direct contact of freshman with faculty and with some of the important linkages that engineering students make during their studies. These communications include informal connections to the student chapters of the professional engineering societies, our COOP and internship programs, S WE, NSBE, ROTC and others. Another important informal contact is with upper level undergraduates and with graduate students who help mentor in the course.

The academic goals of the course include introducing them to effective hands-on experiences with the computer, development of communication skills, how to think about engineering design, and the foundations of manufacturing. These foundations include teaming, communication, vocabulary, a concept of quality, economics, design, ethics, and the environment. Some other concepts are integrated into the course such as design for manufacture, reverse engineering and new products.

All freshman engineering students at the University of Rhode Island enrolled in the first semester one credit module. Most of the engineering students will take the second semester course of two credits. Faculty from every department have volunteered to teach this course and work together in a high performance team. The team plans the course, develops the assignments, teaches the course and provides feedback and revision of the course. Undergraduate and graduate mentors help in the computer laboratory.

Last year we taught a pilot scale course involving three credits that required too much from the students, faculty and from other resources such as lab space. This year the major change is to teach one credit in 7 sections by six faculty in the first semester followed by a two credit course in the second semester. Less laboratory resources are required at any one time and the work is spread over two semesters. Each faculty member stays with the students for the whole semester.

The course is broken down into modules for easy sharing with other Academy Schools. An evaluation is given at the beginning and end of each course. These results will be presented at the meeting. The students are highly motivated and have been making friends and bonding in these courses. We hope this will result in increased retention.

OBJECTIVES

The College of Engineering has been without a common freshman engineering course for more than twenty years. This inhibited direct contact with engineering students with engineering faculty and with engineering subject matter. A student could leave the engineering curriculum after the first year thinking that physics, chemistry and mathematics was what engineering was all about.

The objectives of there-introduction of engineering courses were:

1. to introduce freshman to engineering concepts, problem solving, design concepts, and the engineering culture.
2. to increase the motivation of engineering students by hands on projects.
3. to increase the retention of freshman engineering students.
4. to introduce the foundations for manufacturing across the engineering curricula.

COURSE DEVELOPMENT

A three credit pilot course was introduced in the Fall of 1994. All chemical engineering students were signed up for the course. The course involved one weekly presentation and two hands-on laboratories. The laboratory assignments introduced the students to team work. Sections were limited to approximately ten students. Weekly reports were expected from the students. Faculty from every department supervised a two week module of the course. After a week of general introduction, a computer module that covered word processing, spread sheet use, and graphs involved the students for the first three weeks of the course. Two week topical modules followed included Geotechnical Engineering, Casting Experiences, Design for Variability, Design and Computer Aided Manufacturing, and Construction of an Ocean Waves Simulator.

The students gave high marks to the course and retention was high. However, the resources including laboratory space and equipment were too difficult to schedule for the entire engineering class. A required two week block of time devoted to a module also met strong resistance if the course was going to be required of all students.

In the Fall of 1995 a one credit course was introduced with the same objectives. During the summer all freshman students were signed up for the course. The course would concentrate on a broader computer module. However all the elements of the previous year were maintained including hands-on experiences, engineering problem solving, communications, design and manufacturing experiences, and team-work. Topical modules included Geotechnical Engineering, Casting Experiences, This course received excellent ratings and obtained broad acceptance by the departments.

During the Spring of 1996 a two credit course was introduced to also meet the same objectives. More than half of the engineering students signed up voluntarily for this course. For many others there were course conflicts. While the first semester course used Word, Excel, and Powerpoint, the second semester course uses MATLAB as the fundamental problem solving tool. One big advantage to the use of MATLAB was the introduction of decision making using FOR, IF, and WHILE. There were no reviews of the course by students at the time of writing this paper but we have received very positive feedback by the faculty teaching this course.

For the next academic year Fall 1996 and Spring 1997, these course have been accepted by all department in the college as required courses. A side benefit has been the acceptance of a common first year curriculum for all engineering students.

A project involving the generation of multimedia mini-modules that can run on Intel 486 computers has started. This will be an attempt to institutionalize the major concepts taught in these course and provide the students with visual engineering experiences.

FOUNDATIONS OF ENGINEERING AND MANUFACTURING ACROSS THE CURRICULUM

Foundations of manufacturing was incorporated into the structure of each course wherever it was appropriate. These foundations include the following.

Teaming - It is important that projects which are worked on by groups are divisible tasks. It is helpful if professors give the teams guidance in dividing up projects. One possibility is that groups elect a team manager who is responsible for delegating tasks and providing the professor with a list of the team member responsible for each task. For more information on teaming see the handout.

Communication - written/ verbal/ visual

Reports & Presentations - Professors can ask the students to write reports or give oral presentations about the module or a topic related to the module. Computers with Word Processing Software are available to the students in the engineering computer laboratory in Crawford Hall.

Layouts - Layouts are an important form of visual communication. Through the computer module at the beginning of the semester students will become familiar with the design program Autosketch. Professors can ask students to use Autosketch, which is available in the Crawford computer lab, in order to create layouts of processes, plants, etc. related to the module.

Economics - Terms such as fixed costs, variable costs, profit and breakeven point can be introduced to students. Students should become aware of the importance of economics in design.

Hands-on - Hands on work should be incorporated into all modules. Learning by doing motivates students and keeps them interested.

Design - Design projects should be open ended so students can solve them with a creative and innovative approach. Design practices and constraints can be used to make solving an open ended problem more manageable for the students.

Manufacturing - Professors may ask students to build something after they have designed it. Once something is built students can test its quality and endurance.

Ethics - Students should realize the ethical questions that may arise in engineering design. Professors can give examples of ethical problems they have seen in industry.

Environment - Students should learn that the impact on environment should be a consideration in any design.

Objective - Essential to the success of each module is that the you know what you want the students to achieve and that you successfully communicate your goals to the students. Written objectives would be helpful.

Quality - Quality is the key to survival in todaY's industry. Basic concePts and tools for engineering student Companies have guidelines stating what tools to use during product/process development and during production/manufacturing stages.

EVALUATION FOR FALL 1995

A questionnaire was given at the beginning of the semester to measure attitudes and concepts important to engineering. A similar questionnaire given at the end of the semester allowed the determination of changes in attitude and perspective. In addition an evaluation was given near the end of the course to determine whether the students felt they learned some of the major concepts and skills taught in the course. This instrument is used to help us determine whether we met our objectives. These instruments are included as Figures 1 through 4. The results of the evaluation will be used to help shape next years course. These result are presented in Tables 1 and 2. (now being completed)

CONCLUSION

Providing a foundation for engineering design and manufacturing across the curriculum is a challenging project. Adopting freshman courses and providing a common freshman year is equally as challenging. All six engineering departments at the University of Rhode Island have modified their curriculum to make room for these courses. All are building their curriculum based on these courses.

The courses have been partially funded by the Engineering Academy of Southern New England. Descriptions of the Courses are available to any interested engineering faculty.

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APPENDIX

The modules used during Fall 1994 included:

Geotechnical Engineering

After an introductory lecture the students are formed into teams and provided an objective to have compacted clay soils evaluated for bearing capacity. The first two labs involves the preparation of the samples. The first lab involves the students mixing soil with water to make five samples of increasing water content. In the second lab they compact them into molds at uniform water content and density. The second lecture is used to discuss stress, strain and bearing capacity. The next two labs involves the testing of the samples. The fourth involves applying a load to the samples and determining a stress-strain curve. The last lab is used to write a report which includes the lab data, spreadsheet calculations and graphs of the results.

Casting Experiences

A lecture on the principles of casting was followed by two lab periods. These lab periods involved library research on casting by teams of students. A team of four students retrieved information on four major art pieces that were cast. A report produced using word processing was then required with a description of the pieces, the method used to cast them and other engineering aspects. A second lecture on the different categories of casting and casting defects was followed by two more lab periods where the students measured cast material with a micrometer and calculated averages.

Design for Variability

This module was designed to show how feedback can reduce the effects of variability and to introduce concepts of design for manufacturability. The first lecture introduced the students to automatic control and feedback. The first pair of labs involved control of a cart and pendulum system. The next lecture focused on design for manufacturability involving simple circuit theory, manufacturability issues and worst case analysis. The next pair of labs dealt with the circuit performance variability of a voltage regulator.

Design and Computer Integrated Manufacturing

These two weeks introduced the students to computer-integrated manufacturing. The first week covered an overview of computer-aided design and computer-aided manufacturing and a description of computer numerical control (CC). The first week labs include casting of an aluminum plaque in the foundry and producing the code for drilling of two holes for festering and plaque mounting and then using a vertical milling machine to drill the two holes.

Ocean Waves

The Ocean Waves Module presented an introduction to the mechanics of water waves in the ocean through the design, building and testing of small experimental wave tanks and the direct observation of waves during a beach field trip. The lectures presented the basics of ocean wave creation due to the interplay of wind velocity, duration, fetch distance and wave propagation and transformation in both deep and shallow water. In the labs the fundamental concepts were connected to specific experiments in the small plexiglas wave tanks. Parts of the actual experimental procedures were left open ended to have the teams decide detail of their own experiments. Specific experiments included solitary wave generation and propagation, generation of periodic waves and wave kinetics, wave shooting and breaking, and wave propagation over a submerged obstacle.

FORM 1

Please respond to the following phrase/statements by using the scale below:

No Confidence 1 — 2 — 3 — 4 — 5 *Very Confident*

I am confident in my ability to:	No Confi-dence				Very Confident
1. work in groups.	1	2	3	4	5
2. work independently.	1	2	3	4	5
3. work on hands on projects.	1	2	3	4	5
4. do computer programming.	1	2	3	4	5
5. use computer applications (i.e., word processors, spread sheets).	1	2	3	4	5
6. do the work of an engineer.	1	2	3	4	5
7. problem solve.	1	2	3	4	5
8. follow engineering ethics.	1	2	3	4	5
9. give oral presentations.	1	2	3	4	5
10. write technical reports.	1	2	3	4	5

In the space provided below, please answer the following question to the best of your ability.
What does an engineer do?

FORM 1 **EASNE: STUDENT SURVEY**

Social Security #: ____________________

Please respond to the following phrase/statements by using the scale below:

No Interest 1 — 2 — 3 — 4 — 5 *Very Interested*

I am interested in:	No interest				Very interested
1. working in groups.	1	2	3	4	5
2. working independently.	1	2	3	4	5
3. working on hands on projects.	1	2	3	4	5
4. computer programming.	1	2	3	4	5
5. using computer applications (i.e., word processors, spread sheets).	1	2	3	4	5
6. the work of an engineer.	1	2	3	4	5
7. the process of problem solving.	1	2	3	4	5
8. engineering ethics.	1	2	3	4	5
9. giving oral presentations.	1	2	3	4	5
10. writing technical reports.	1	2	3	4	5

Please respond to the following phrase/statements by using the scale below:

Not Important 1 — 2 — 3 — 4 — 5 *Very Important*

I think the following are important:	Not Important				Very Important
1. working in groups.	1	2	3	4	5
2. working independently.	1	2	3	4	5
3. working on hands on projects.	1	2	3	4	5
4. computer programming.	1	2	3	4	5
5. using computer applications (i.e., word processors, spread sheets).	1	2	3	4	5
6. the work of an engineer.	1	2	3	4	5
7. the process of problem solving.	1	2	3	4	5
8. engineering ethics.	1	2	3	4	5
9. giving oral presentations.	1	2	3	4	5
10. writing technical reports.	1	2	3	4	5

FORM 2 EASNE: STUDENT SURVEY

Social Security #: ____________________________

This is an experimental course designed to introduce new engineering students to several areas we feel are important in manufacturing engineering. The following six categories represent some of the major goals for the students in the course. Please **rate the extent to which you agree these goals were reached in the course** by circling the appropriate number next to each item.

DISAGREE 1 — 2 — 3 — 4 — 5 **AGREE**

1. Communication using technology	
a. Introduce students to report writing using word processing	1 2 3 4 5
b. Introduce students to computer generated graphs	1 2 3 4 5
2. Manufacturing	
Provide an introduction to concepts important to manufacturing	1 2 3 4 5
3. Teaming	
Provide opportunities for students to work as members of a team	1 2 3 4 5
4. Hands-on	
Provide students with "hands-on" experience in various engineering laboratories	1 2 3 4 5
5. Economics	
Introduce ideas about costs and their relationship to manufacturing processes	1 2 3 4 5
6. Design	
Provide students with laboratory experiences that give an introduction to the area of engineering design	1 2 3 4 5

FORM 2

In the spaces provided below, please respond to the following questions.

1. To what degree did this class influence your decision to continue in Engineering?

2. How well did your work teams function?

3. To what extent did this class provide the opportunity for you to work with individuals from industry?

4. Did you have any opportunities in this class to work with students/professors from other New England universities?

5. What do you feel was the most beneficial aspect of the course?