2006-1626: THE DEVELOPMENT OF A MECHANICAL ENGINEERING FRESHMAN PROGRAM

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The Development of a Mechanical Engineering Freshman Program

Introduction

Many of the top engineering schools in the country conduct a freshman engineering program. These programs provide the opportunity to integrate students very early into the culture of their respective engineering disciplines. The Department of Mechanical Engineering at Michigan State University (MSU) has not conducted a freshman program, mainly due to the university-wide junior admission-to-major criteria. However, in the past year, the department has identified the need for such a program and has made a commitment to its development. This paper addresses the development of the MSU Mechanical Engineering Freshman Program.

Program Goals

In developing the MSU Mechanical Engineering (ME) Freshman Program, a task force was assembled that included the two principal instructors and the associate chair for undergraduate programs of the department. The instructors selected for the task force were those deemed most well suited to the development, implementation and delivery of freshman-level courses due to their experience at that level and their expertise with the computer tools identified for the new courses. One of the first tasks of this group was to develop a set of goals and objectives for the program. A draft set of goals and objectives were developed and distributed to the faculty for comment. Following feedback from the faculty, the goals below were formalized:

1. Introduce students to the mechanical engineering discipline and profession.

2. Demonstrate how basic mathematics and science fits into engineering practice.

3. Introduce students to the engineering design problem solving method in a rigorous fashion.

4. Teach students to use computer applications such as NX®, MATLAB®, and Excel®.

5. Help students develop their communication, study, organizational, and teaming skills.

6. Prepare students for and begin their integration into the culture of the mechanical engineering program.

Developing the Program Structure

With the preliminary set of goals developed, the task force then turned its attention to the structure of the program. One constraint was to preserve the number of courses and credits currently in the MSU ME program. It was decided to investigate possible major modification and ultimate replacement of the two current introductory computer tool courses, Engineering Graphic Communications (ME 180) and Technical Computing and Problem Solving (CSE 131), for the new freshman program. ME 180 is a 3 credit course taught in a one hour lecture and two 2-hour lab periods per week format. It focuses on the teaching of NX® as a mechanical design

tool. CSE 131 is a 3 credit course taught in a one hour lecture and two 80-minute lab periods per week format. It focuses on the teaching of Excel® and MATLAB® as analysis tools.

Two new courses have been developed to serve as the core of the Freshman Program that will replace ME 180 and CSE 131 in the ME curriculum. The two courses are:

ME 101 Creative Engineering Solutions I
ME 102 Creative Engineering Solutions II

Though an emphasis of these two courses will be the teaching of NX® (ME 101), Excel® (ME 102) and MATLAB® (ME 102), the teaching of these computer skills will be integrated with learning the engineering design problem solving method through an introduction to the discipline of mechanical engineering. Students will be expected to use all of these computer skills throughout the two course sequence. The mode of teaching for both courses will be two 1-hour lectures and two 2-hour laboratory periods per week.

Pilot Program Students

This program was run on a pilot basis during the 2005-2006 academic year. For such a pilot, a small number of students needed to be identified to participate in the program. It was decide to tap into the current Residential Option for Science and Engineering Students (ROSES) operated by the MSU College of Engineering.

ROSES, is an integrative approach that directs resources to students making the transition from high school to college life at MSU. ROSES students are those with an interest in science, engineering, agriculture and natural resources who choose to live in a residential community. The ROSES program provides a strong sense of community and academic support that helps students reach their academic goals. All ROSES participants are required to enroll in a seminar course with sections grouped by potential engineering major. Students are introduced to the academic resources available at MSU, explore majors within the College of Engineering, meet faculty members in their chosen major, and meet and work with their peers.

The ROSES students in the mechanical engineering seminar course section were chosen as the cohort group for the pilot program. During summer freshman orientation, when they enrolled for fall 2005 semester classes, these students were advised to take the new ME 101 course along with the ROSES seminar course. A handout was developed and distributed to advise the students and it is shown as Attachment 1. Typically, these students are highly motivated, strong academically, and tend to complete their academic careers in mechanical engineering, which makes them ideal for the pilot program. For the fall 2005 semester, the ME ROSES seminar section had an enrollment of 20 students, 17 of whom enrolled in ME 101, as it fit into their respective semester schedules. For the second course, ME 102, taught in the spring 2006 semester, 14 of the original 17 fall semester students enrolled (an attrition rate of 18%). Of the 3 students that did not continue with the second course, two changed majors and one left the University.

Course Descriptions

Following are the initial course descriptions developed for the new courses:

ME 101 Creative Engineering Solutions I

Graphics is a required tool for engineers, but students also need to be provided with hands-on engineering experience. The revised Engineering Graphic Communication course has three basic components. They are: 1) Orientation to the MSU Department of Mechanical Engineering and an introduction to computers, 2) Visual communications, and 3) Design experience. The design experience is spread throughout the semester. The basic components are described briefly below:

During the first week of the course, the students will be introduced to the University environment. They will be given information about the services available within the University and the College. The importance of good study habits, ability to manage time, and an ability to prioritize work will be emphasized. During the first class, the students will be divided into teams and assigned the first design project. The design projects are discussed in more detail below.

In the second week, the students will be introduced to computers. This includes an introduction to the PC environment and using e-mail. They will be introduced to the Internet and required to build a personal home page.

The visual communication portion of the course introduces students to the importance of sketching for creating engineering pictorial and perspective drawings. Students will also learn to use NX® for three-dimensional solid modeling. Along with sketching, the students will learn geometric dimensioning and tolerancing (GD&T) and its importance to the engineering profession.

In the Engineering Graphic Communication (pilot) course, the students will be exposed to three small hands-on, design projects. On the first day of the course, the students will be asked to design and build a balsa wood bridge. As part of this project, they will also maintain an engineering laboratory notebook. This project will give the students an exposure to engineering while allowing them to make use of their intuitive abilities. The students will be given strict completion deadlines. This will require them to use their time management skills. The students will do this in small groups, which requires them to work as teams. The second project will be to reverse engineer a product and explore some basic manufacturing and assembly techniques. Disassembly of commercial products also exposes students to the use of basic hand tools. The last project will be slightly more involved. The basic premise is to have the students bring together all the things they have learned in the course. This project is to design and build, along with computer modeling, a product such as a car powered by a spring from a mouse trap. The students will maintain design notebooks detailing their activities. In addition to the design and build, the students will write engineering reports which will include parts and assembly drawings created using NX®. On the final day allocated to this project, students will make formal presentations of their work to the rest of the class using presentation programs.

ME 102 Creative Engineering Solutions II

As of submission of this paper, this course was just underway. The weekly course schedule, as distributed to the students, is shown in Appendix 2. As seen in the schedule, this course will introduce students to the mechanical engineering curriculum while focusing on engineering problem solving using spreadsheets (Excel®) and advanced computational tools (MATLAB®) as well as performance of a major mechatronic project.

Spreadsheets provide a convenient tool for introducing concepts of problem solving to freshmen. They have also become more versatile and powerful over the years so that many engineering problems can be solved using them. In this course, the students will be introduced to spreadsheets and how to do basic operations with them. They will learn a systematic approach to problem solving extensively using MATLAB® and also how graphical tools are used in engineering and scientific data presentation. They will also be introduced to the concept of truncation and round-off errors. Students will also learn about curve fitting to paired data and they will be introduced to the concepts of measurements, errors and how statistical analysis is used.

Problem solving is the foundation of all engineering activities. This course is designed to help students develop problem-solving skills and to understand the general processes in engineering design. Students will be introduced to problem definition creation, course of action decision making, generation of solutions, and implementation of best solutions. They will learn the importance of evaluation and how it is an inherent part of the engineering process. Topics such as product safety and liability, professional ethics and environmental considerations will also be covered. The students will also explore engineering design and analysis through a three-week mechatronic system project. During this project, students will learn a new technology through analysis of past product designs, be trained in that technology, define and develop a new product, and produce a presentation on that new product.

Assessment of the Pilot Program

Assessment of the program will consist of two parts: the courses and the program. Two surveys have been developed and will be administered to assess the effectiveness of each course. A focus group will be conducted with the students in the spring to assess the effectiveness of the program and how well the pilot obtained the program goals. In addition, the students in the courses have been periodically polled for feedback as to the effectiveness of the content and methods used for material delivery. The task force has also met periodically to document program successes and identify areas for improvement.

Resource Requirements

To bring a new program, such as this, to fruition, which has such a different integrating approach from the standard teaching of computer skills, requires a considerable expense of resources. Below is a list of the initially-identified resource needs:

Undergraduate Student Labor: Junior and senior mechanical engineering majors will be hired as instructional assistants for the laboratory component of the courses. Some

additional students will be hired to assist in the development of course materials. Projected pilot program cost: $6,000.

Faculty/Staff Training: Some additional training of the faculty and staff comprising the instructional team on the computer tools to be used in the program will be needed. Projected pilot program cost: $1,000.

Project Supplies: Supplies will be needed for the hands-on projects and classroom demonstrations used in the program. Projected pilot program cost: $2,000.

Travel: During the development process, the instructional team may wish to travel to another institution to benchmark our program or we may wish to invite a faculty member from another institution visit MSU to comment on our progress. Projected pilot program cost: $1,000.

A proposal detailing the proposed ME freshman engineering program and its objectives was submitted to the Daimler-Chrysler Corporation Foundation. A $10,000 curriculum development grant was secured from them to fund the development of the pilot program.

Future Curriculum Development

At the writing of this paper, the first course in the pilot program had been completed and the second course was underway. Even with this limited experience, it is clear that two modifications must be made prior to implementation. First, the order of the courses needs to be reversed. That is, the current second course which has a greater emphasis on an introduction to mechanical engineering, should logically be the first topic in an ME freshman program. Second, with the level of competency of NX® desired, very little else was covered in the ME 101 pilot course. The program may need to make some adjustments in the competency level in NX® required for the students.

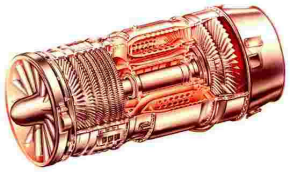
Current plans call for the pilot program to be repeated next academic year (2006-07) with the changes suggested above being incorporated. It is also planned that the next group of pilot program students be expanded to incorporate not only a larger group, but include other mechanical engineering freshman in addition to ROSES program students.

One of the major challenges still ahead is the scaling up of the program from a small number of hand selected students in a single section to University-wide accessibility to the course by prospective mechanical engineering students, which will lead to expected enrollments of 200 to 300 per semester.

Appendix 1 – Freshman Program Handout

Mechanical Engineering Freshman Experience

Engineers are problem solvers and much of undergraduate engineering education deals with developing problem solving skills and abilities. The Department of Mechanical Engineering believes that the sooner problem solving can be introduced to students, the stronger their educational experience and problem solving abilities will be. Two new courses are being developed at the freshman level to facilitate this education. This year ROSES students have the unique opportunity to take these two new courses:

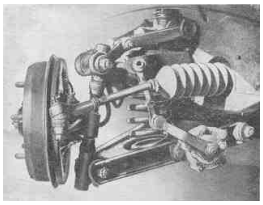


ME 101 Creative Engineering Solutions I

ME 102 Creative Engineering Solutions II

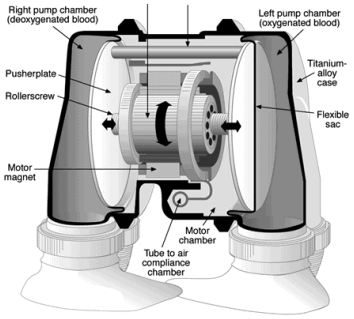
In both of theses courses students will learn about the practice and disciplines of mechanical engineering. ***Problem solving techniques*** will be introduced that will use ***hands-on experiences***, ***calculation experiences***, and ***computer experiences*** to solve many real world mechanical engineering problems. The courses will also include ***extensive computer experiences***, as students learn programs that allow them to draw on the computer and carry out analysis on the computer. These two courses will be used in the student's curriculum to replace ME 180 Engineering Graphic Communications and CSE 131 Technical Computing and Problem Solving.

For the 2005-2006 academic year, only students in the Mechanical Engineering ROSES section (EGR 291, section 4) will be taking these courses. Since these are new courses, they are offered under a generic number, ME 399. They are scheduled as follows:



Fall 2005
ME 399 section 601 "Creative Engineering Solutions I"
3 credits taught as 1 hr lecture, 1 hr recitation, 4 hrs lab
Will substitute for ME 180 requirement.
Tu 3-3:50 (lecture)
Tu 4:10-5 (recitation)
W Th 3-4:50 (lab)

Spring 2006
ME 399 section 601 "Creative Engineering Solutions II"
3 credits taught as 1 hr lecture, 1 hr recitation, 4 hrs lab
Will substitute for CSE 131 requirement.
Mon 10:20-11:10 (lecture)
Tu Th 10:20-12:10 (lab)
Wed 10:20-11:10 (recitation)



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In taking these new courses, the standard schedule for a mechanical engineering student changes somewhat. A revised standard schedule is shown below:

Freshman Year

Fall	Credits	Spring	Credits
ME 101*	3	ME 102*	3
CEM 141	4	MTH 133	4
CEM 161	1	PHY 183	4
ISS 2XX	4	WRA 1XX	4
MTH 132	3		
EGR 291	1		

Sophomore Year

Fall	Credits	Spring	Credits
Bioscience (AT)	3/4	IAH 20X	4
Elective	3	ME 201	3
CE/ME 221	3	ME 222	4
MTH 234	4	MSE 250	3
PHY 184	4	MTH 235	3

* To be taken as ME 399

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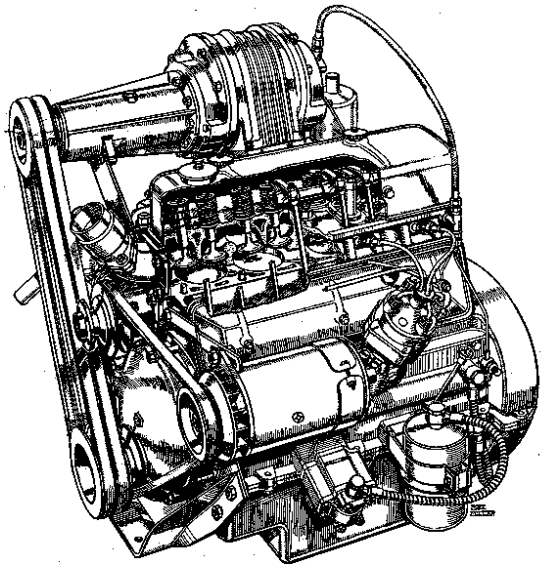

Appendix 2 – ME 102 Creative Engineering Solutions II Schedule

Week	Date	Monday Lecture Topic	Tuesday Lab Topic	Wednesday Recitation Topic	Thursday Lab Topic
1	1/9	Introduction	ME Curriculum *HW #1*	Problem Solving #1	ME Discipline *HW #2*
2	1/16	MLK Day No Class	Report Writing & Presentations *HW #3*	Problem Solving #2	Technical Writing *HW #4*
3	1/23	Forces in Structures #1	Excel #1 *HW #5*	Forces in Structures #2	Excel #2 *HW #6*
4	1/30	Materials #1	Excel #3	Materials #2	**Project 1 Presentations**
5	2/6	Fluids #1	MATLAB #1 *HW #7*	Fluids #2	MATLAB #2 *HW #8*
6	2/13	Thermal Systems #1	MATLAB #3 *HW #9*	Thermal Systems #2	MATLAB #4 *HW #10*
7	2/20	Motion & Power #1	MATLAB #5 *HW #11*	Motion & Power #2	MATLAB #6 *HW #12*
8	2/27	**Lecture Exam #1**	MATLAB #7	Mechanical Design	**Project 2 Presentations**
9	3/13	Mechatronics #1	Mec Lab #1 *HW #13*	Mechatronics #2	Mec Lab #2 *HW #14*
10	3/20	Mechatronics #3	Mec Lab #3 *HW #15*	Mechatronics #4	Mec Lab #4 *HW #16*
11	3/27	Mechatronics #5	Mec Lab #5	Mechatronics #6	**Project 3 Presentations**
12	4/3	NX Optimization #1	NX Tools #1 *HW #17*	NX Optimization #2	NX Tools #2 *HW #18*
13	4/10	NX Structural Analysis #1	NX Tools #3 *HW #19*	NX Structural Analysis #2	NX Tools #4 *HW #20*
14	4/17	Problem Solving #3	Engineering Solutions #1 *HW #21*	Problem Solving #4	Engineering Solutions #1 *HW #22*
15	4/24	**Lecture Exam #2**	Work on Project #4	Course Wrap Up	**Project 4 Presentations**