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ABSTRACT

This document provides the keynote address and papers delivered at the 1991 California State University Conference on Innovation in Engineering Education which focused on the pre-engineering curriculum. The conference was convened as a collaborative effort by faculty to address the following issues in engineering education: (1) the attraction and retention of women and minorities in the engineering field; (2) curricula revision to allow for innovation; (3) the incorporation of technology into teaching and learning styles; (4) better preparation of incoming high school graduates for pursuing an engineering curriculum; and (5) measuring teaching effectiveness. Speeches and papers and their authors are as follows: "the Engineering Council for Teaching and Learning" (C. E. Rathmann); "Using Distance Learning Technologies to Teach Pre-Engineering to High School Students" (D. P. Coduto); "Computer Solution of Engineering Problems" (D. E. Kirk and A. M. Davis); "A Workplace in Ergonomics and Engineering Design for High School/Pre-Engineering College Students" (K. Abedini); "An Introductory Engineering Course to Provide Skills and Motivation" (S. de Haas and K. Ferrara); "An Engineering Orientation Course as a Pre-Engineering Retention Tool" (C. O. Allen and V. V. Krishnan); "Introduction to Engineering Design: A Freshman Mechanical Engineering Course" (R. Roth); "Technology Based Instruction in Integrated Computer Graphics/CAD" (S. Krishnamurthy and N. Mousouris); "Design of a Modern Curriculum for Lower Division Engineering Core" (N. A. Ibrahim). (Contains 6 references.) (GLR)

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Major objectives of this initiative are as follows:

- increase awareness of the work of the CSU Institute for Teaching and Learning;
- increase access to the work of CSU/ITL affiliates;
- begin to build a subset of information on teaching and learning that supports *The National Teaching and Learning Forum (NTLF)*, ERIC/HE's newsletter;
- encourage use of the ERIC system by CSU/ITL member affiliates and the *NTLF* readership; and
- test a model for collaboration between ERIC/HE and a major higher education system.

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Office of the Dean
College of Engineering

Summer, 1991

Dear Engineering Faculty Member:

In 1988, the Trustees of the California State University created the Institute for Teaching and Learning. An offshoot of that effort, the Engineering Council for Teaching and Learning (ECTL), was created by engineering faculty from across the CSU in November, 1989, with the express purposes of investigating innovative ways of attacking the current problems in engineering education. I am happy to present this volume to you on behalf of ECTL.

Actually because you are a faculty member in one of the CSU's engineering programs, you are already a de facto member of ECTL. This is very much a grass roots organization because we believe many of the problems engineering educators face are best addressed by these educators themselves - problems like the pipeline and the curricula and classroom technologies and student preparation and assessment. ECTL is in the process of establishing a network of engineering educators from across the CSU; your dean has been helpful in our initial efforts and has indicated his support for our goals. However, the success of ECTL depends on the widespread involvement of all our engineering faculty. If you are interested in assisting with the solutions of problems that the people in the trenches are facing, please feel free to contact me to indicate your interest.

The Second Annual CSU Conference on Innovation in Engineering Education is scheduled to be held at California State University, Sacramento, in Spring, 1992. Please watch for the call for papers and plan to join your colleagues in discussing exciting changes in the engineering curricula in the CSU.

Sincerely,

Carl Rathmann

Carl Rathmann, Chair, ECTL

PROCEEDINGS

FIRST ANNUAL CSU CONFERENCE ON INNOVATION IN ENGINEERING EDUCATION

"The Pre-Engineering Curriculum"

April 26, 1991

School of Engineering
San Jose State University
San Jose, California

Sponsored by

The Engineering Council for Teaching and Learning

Funded by a grant from
The Institute for Teaching and Learning
of the California State University

First Annual CSU Conference on
Innovation in Engineering Education
San Jose State University
April 26, 1991

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SAN JOSE STATE UNIVERSITY

SCHOOL OF ENGINEERING

APRIL 26, 1991

FIRST ANNUAL CSU CONFERENCE ON INNOVATION IN ENGINEERING EDUCATION THE PRE-ENGINEERING CURRICULUM

PROGRAM

9:00-9:30 AM: WELCOME AND INTRODUCTION

———J. Pinson, Dean of Engineering SJSU

———A.M. Davis

———C.E. Rathmann

9:30-10:00 AM: USING DISTANCE LEARNING TECHNOLOGIES TO TEACH PRE-ENGINEERING TO HIGH SCHOOL STUDENTS———D.P. Coduto
Department of Civil Engineering
Cal Poly Pomona

10:00-10:30 AM: INTRODUCTION TO ENGINEERING COMPUTATION
———D.E. Kirk
———A.M. Davis
Department of Electrical Engineering
San José State University

10:30-11:00 AM: BREAK

11:00-11:30 AM: A WORKSHOP IN ERGONOMICS AND ENGINEERING DESIGN

———K. Abedini
Industrial and Manufacturing Engineering
Cal Poly Pomona

11:30-12:00 AM: AN INTRODUCTORY ENGINEERING COURSE TO PROVIDE SKILLS AND MOTIVATION
———K. Ferrara
———S. de Haas
Department of Electrical Engineering
Cal. State. Sacramento

12:00-01:00 PM: LUNCH (Catered)

01:00-01:30 PM: ECTL (ENGINEERING COUNCIL FOR TEACHING AND LEARNING)
———C. Rathmann
Cal Poly Pomona

01:30-02:00 PM: AN ENGINEERING ORIENTATION COURSE AS A PRE-ENGINEERING RETENTION TOOL
———C.O. Allen. Minority Eng. Prog.
———V.V. Krishnan Engineering
San Francisco State U· ‹ersity

02:00-02:30 PM: INTRODUCTION TO ENGINEERING DESIGN: A FRESHMAN MECHANICAL ENGINEERING COURSE AT CSUC
———R. Roth
Department of Mechanical Eng.
Cal. State. Chico

02:30-03:00 PM: DESIGN OF A MODERN CURRICULUM FOR LOWER-DIVISION ENGINEERING CORE
———N.A. Ibrahim
General Engineering
San José State University

03:00-03:30 PM: TECHNOLOGY BASED INSTRUCTION IN INTEGRATED COMPUTER GRAPHICS/CAD
———K. Krishnamurthy
Mechanical Engineering Department
CSU Fullerton

Proceedings
First Annual CSU Conference on
Innovation in Engineering Education

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The Engineering Council for Teaching and Learning
Keynote Address

C. E. Rathmann
College of Engineering
California State Polytechnic University, Pomona

Donald H. Thomas and Alan Lawley in their article "Drexel's E^4 Project: An Enhanced Educational Experience in Engineering" (JOM, March, 1991) provided some sobering thoughts, though not new, on the productivity of engineering education in the United States. Paraphrasing their article,

> It seems safe to say that while the undergraduate engineering student body demographics have undergone severe and fairly rapid changes during the last decade, the teaching of engineering in most cases continues as if nothing has changed. Retention rates in science and engineering for U.S.-born students have decreased dramatically, and the academic performance of those students who are retained is typically below their potential levels of excellence. Nearly 42% of all students who enter undergraduate engineering and science programs drop out by the end of the freshman year; another 23% leave before graduating. Two-thirds of entering students begin but do not complete an engineering or science degree.

This pattern has now resulted in a downward trend of new bachelor's degree awards. In 1986 the production of undergraduate degrees in engineering peaked at 78,178; in 1990, the awards had fallen to 65,967, the start of a downward trend expected to persist into the mid-1990's. The fact that the numbers of B.S. degrees continues to climb in California tends to mask the national downward trend from us in particular. Bachelors degrees awarded to underrepresented minorities increased slightly in 1990, but awards to women remain at the historic 15%.

While some of the data on degrees certainly reflects trends in birthrates, the undergraduate retention rates in engineering are hopefully causing our national planners some sleepless nights. Again from Thomas and Lawley, "Everyone has a different opinion as to the chief causes of the dropout problem. Students and others blame the

university faculty members and their outmoded teaching methods. The faculty in turn blame everyone else, from the high schools to the students themselves---poorly prepared, short attention spans, television and video games, the instant gratification syndrome, etc."

It is a copout for any one group to blame any other one group for the problem. It is simplistic to assume that the current situation in engineering education has been caused by anything less than a cumulative effect of many factors acting over decades. Nor is it an effect that is limited to engineering. That recognition is what led the Trustees of the California State University in 1988 to establish the Institute for Teaching and Learning (ITL). The ITL has now established system-wide faculty groups in over a dozen disciplines to attack current problems at the grass-roots level. In fact, ITL is funding this conference. One of the offshoots of the ITL, the Engineering Council for Teaching and Learning (ECTL), was formally established at Lake Arrowhead in November, 1989, to develop innovative ways of addressing these problems specifically in the engineering curricula. ECTL has now matured enough to sponsor this conference, with the gracious assistance and support of Dr. Pinson. I need to publicly thank Dr. Davis for his service as chair of this conference.

At its founding, the members of ECTL, faculty from each of the engineering colleges within the CSU, agreed that five topics need urgent attention and that each is best addressed by faculty directly:

- the attraction and retention of all students, including minorities and women.
- revising the currently jammed curricula to permit innovations
- incorporating technology into teaching and learning styles
- better preparation of high school students for pursuing an engineering curriculum
- measuring teaching effectiveness

This conference marks the first collaborative attempt by faculty to address these issues on a broad front within the CSU. And who better to do it! What a laboratory we have, in excess of 25,000 engineering students just waiting for improved methods of teaching and learning! What an opportunity! Changes we institute will change engineering education across the nation.

We envision this continuing conference as an ideal vehicle for sharing and disseminating information and experience about the numerous and on-going innovative activities of the CSU Engineering faculty. In subsequent conferences, ECTL plans to focus on each of the five emphasis areas first delineated at our founding.

We have much to report because much is going on. There are hotbeds of activity among our faculty. There are ongoing efforts to bring video graphics and solids modeling into the curriculum to allow our students to get more of a feel for the "art" of engineering. There are outreach efforts whereby our faculty go out to elementary schools to contribute to the technical awareness of students still in the formative stages. All kinds of curriculum innovations are being proposed and we'll be hearing about some of them.

On another front, I am happy to report to the members of ECTL that a proposal is being submitted to NSF at this very moment to establish a coalition of the faculties of the CSU engineering schools; most of the engineering campuses have contributed to its preparation and have committed themselves to a five-year coalition involvement, an effort begun by ECTL at its founding. Part of that proposal includes a request for funding for the second CSU Conference on Innovations in Engineering Education!

The future is fraught with opportunity! What we do in engineering education can have long-term consequences. Can we ignite our colleagues? Success depends on the collective effects of individual efforts. Only if each of us is committed will ECTL have a future. This is not something anyone else can do for us. It is upon the faculty of the largest teaching university in the world that the obligation rests. Will we accept it? In spite of the lack of immediate personal reward and decreasing fiscal support? Will we do it for the love of our two professions? Will we do it merely because we are very good teachers? I think the efforts we will hear about today testify that we are already doing it! Here's to my hope that it can continue...

Using Distance Learning Technologies to Teach Pre-Engineering to High School Students

Donald P. Coduto
Professor of Civil Engineering
California State Polytechnic University
Pomona, California

Engineers: Supply and Demand

Today's society is much more dependant on technology than ever before. Nearly every aspect of life now relies on technology in some way. As a result, nations which taken a leadership role in the development and implementation of technology, such as Japan and Germany, are those which have become the economic powers of the world.

The United States has traditionally been among the world leaders in technology, and this has required ever larger numbers of trained engineers in the workforce. For example, from 1972 to 1986 the number of engineers employed in the United States rose at an average rate of 7% per year. Although this rate of growth may be slower in the years to come, the National Science Foundation anticipates an additional 35 to 45% increase in demand by the year 2000[1].

Unfortunately, we are not producing enough engineering graduates to meet this demand. Figure 1 shows the number of BS degrees in engineering earned in the United States each year from 1952 to 1990[2,3]. Although the annual number of graduates increased rapidly during the late 1970's and early 1980's, an equally rapid decline has occurred since then. Thus, we now live in a time of decreasing supplies and increasing demand.

One of the reasons for the decline in the production of engineering graduates is the decreasing number of college age people in the population. The data in Figure 2 shows that this trend is likely to continue through the late 1990's[2]. However, an even greater reason is that a smaller percentage of college students are selecting engineering as a career objective. This is especially true

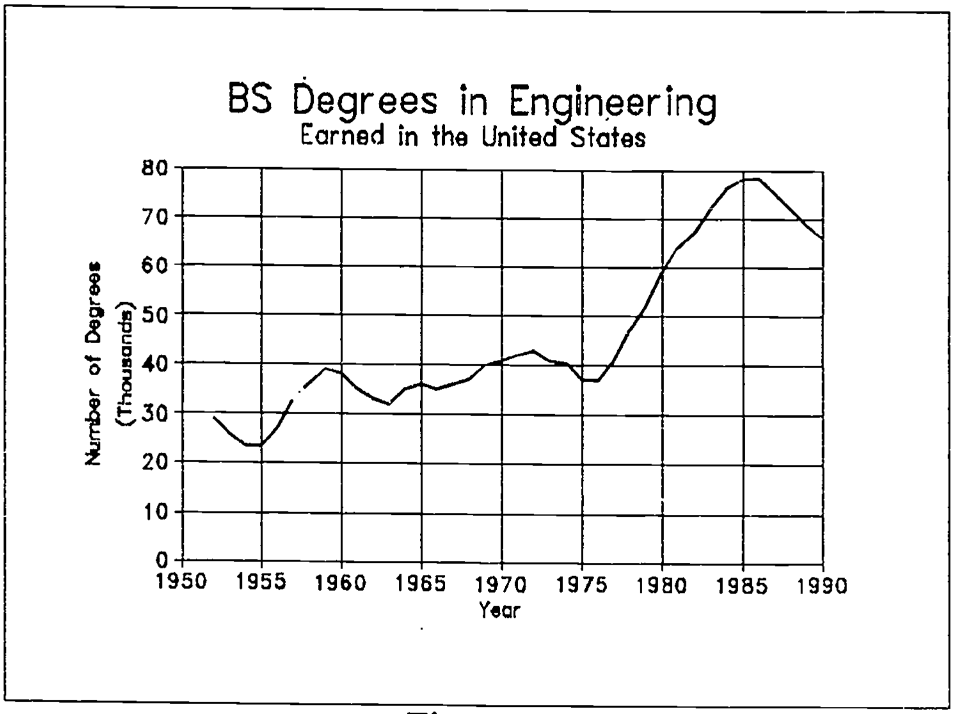

Figure 1

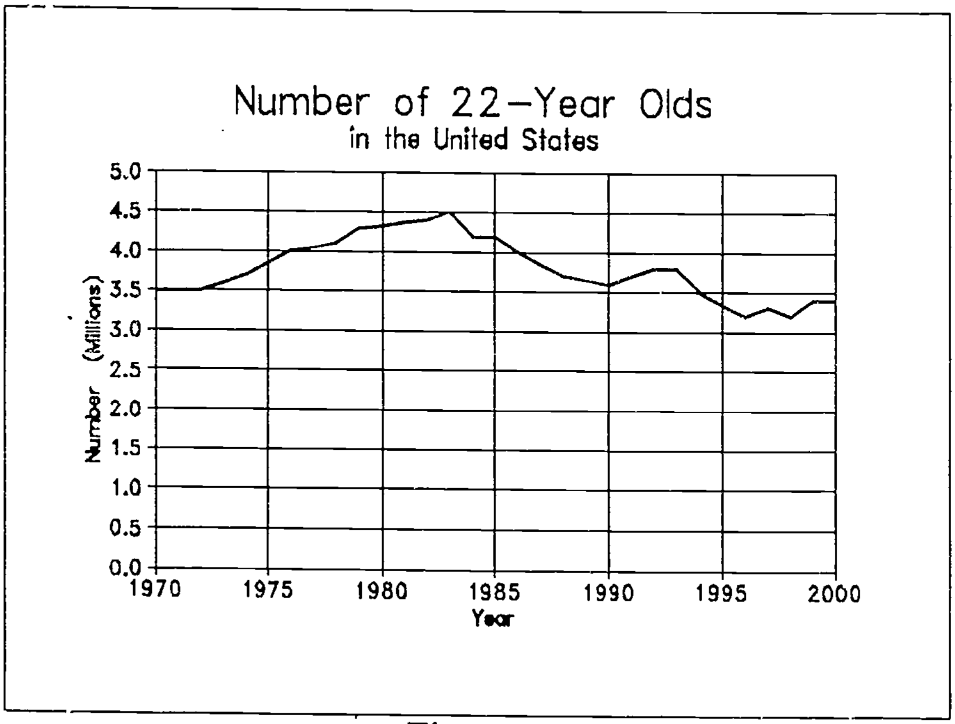

Figure 2

among native-born Americans. According to a study conducted by the Cooperative Institutional Research Program, about 12% of college freshmen expressed an interest in engineering in 1982, while only 8.5% did so in 1987. Apparently, careers in business administration, law and other professions are more attractive.

It appears that many of today's college-bound young people select a career path based primarily on its earnings potential. Engineering does not seem to fit this mold and is viewed as being a difficult course of study which leads to careers which are dry and repetitive.

Given these circumstances, it is in our nation's best interests to actively promote engineering as a career.

Reaching High School Students

In 1989, President Bush and the nation's governors established six national goals for achieving excellence in education. One of these goals was that "by the year 2000, U.S. students must be first in the world in math and science achievement."[4] Engineers applaud this effort and are encouraged by the increased emphasis on math and science in elementary and secondary schools. However, the connection between these skills and careers in *engineering* is often lost. Although there certainly is a need for more professionals in the basic sciences, the greatest needs are in engineering.

It seems that most high school teachers and guidance counselors are not sufficiently familiar with career opportunities in engineering and thus do not promote engineering as strongly as they should. Without the necessary information and encouragement, potential engineering students often choose other majors.

A number of organizations outside of the K-12 schools have attempted to strengthen the connection between math and science skills and careers in engineering. A good example is the "Discover-E" (discover engineering) program sponsored by the National Society of Professional Engineers. This program brings practicing engineers and high school students together during Engineer's Week. Another effort, known as "Engineers for Education" is sponsored by the National Coalition of Engineering Societies. It is attempting to establish on-going partnerships with every elementary and secondary school in the nation.

These efforts are admirable and should be continued. Hopefully they will be an encouragement to students, especially at the high school level, as well as to teachers and guidance counselors. However, once this seed has been planted, students need much more information in order to properly prepare for a career in engineering. The potential engineering student needs to make many decisions, including:

- Which branch of engineering to study
- Which university to attend
- How to prepare academically

Most engineering students have not thought through these issues with sufficient care. As a result, they may not select the most appropriate engineering discipline and are often not properly prepared to begin their university studies.

Distance Learning

Universities which teach engineering, especially those which emphasize undergraduate education, are in an excellent position to provide the necessary career guidance to high school students. Unfortunately, the logistics of physically going to high school campuses makes such meetings very difficult. The realities of budget constraints and personnel limitations are such that very little face-to-face contact time is possible.

Fortunately, new technologies have provided a means of addressing this problem. By the use of *distance learning methods*, we are now able to gather together students from a variety of locations into a single "electronic classroom". There are a number of ways this can be done, but this paper will only address the technique of transmitting images of the instructor via live television and receiving audio feedback from the students via telephone. This system permits interaction between the instructor and the students, even though each remains at their home campus.

The Federal Communications Commission has a provision for this type of television service. It is known as an Instructional Television Fixed Service (ITFS) and utilizes low-power microwave links to transmit the audio and video signals. Many of the CSU campuses, including Cal Poly Pomona, have an ITFS program in place. In some cases they have been used to teach graduate level courses to off-campus students or special seminars and training courses to schools, industry and public agencies. At Cal Poly, ITFS has been used primarily to teach freshman level college level courses to advanced high school students. Most of these have been general education courses such as Psychology, Biology or Art.

The design of the ITFS program at Cal Poly, known as PolyNet, is shown in Figure 3. Television cameras, audio equipment, lighting and other necessities have been installed in a former classroom to create the PolyNet studio. This equipment is operated by one or two students, typically communication arts majors. The audio and video signals of the instructor are first sent by a short microwave link to a hill on campus known as Kellogg Hill. There, a repeater sends the signals to Mt. Wilson (a tall mountain located north of Pasadena). Another repeater rebroadcasts the signals directly to the high schools.

A network of telephone feedback provides interaction between students and the instructor. The students at each school have a microphone with a push-to-talk button. These are tied by standard telephone lines in a "party line" arrangement and are eventually connected to a speaker in the PolyNet studio. This ability for live interaction is an important part of the system. If it were not present, one could simply send out pre-recorded video tapes and eliminate the live broadcasting network.

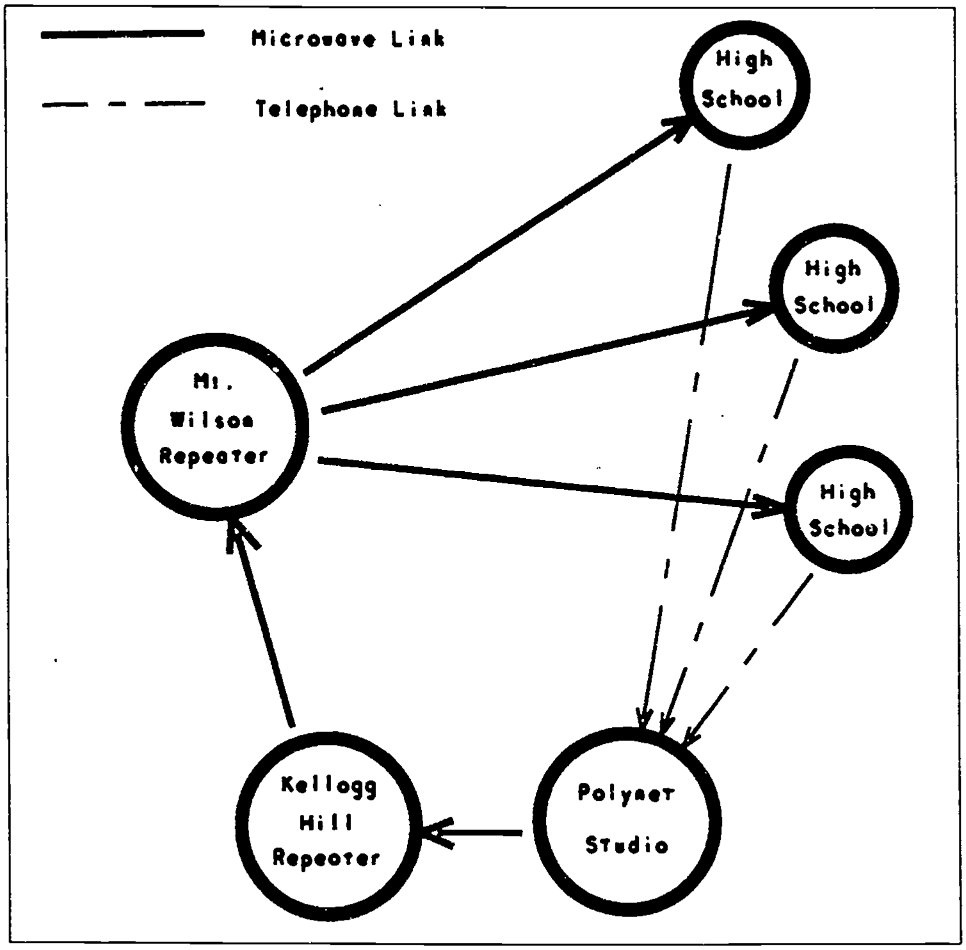

Figure 3

PolyNet Introduction to Engineering Course

Recognizing the potential of ITFS, the College of Engineering at Cal Poly worked with the Distance Learning Center to develop an Introduction to Engineering course for high school students. This freshman-level course, which was first offered in 1986, meets four hours per week for ten weeks. Students who successfully complete the course receive four quarter units of college credit.

The goals of this course are to help the student in the following ways:

- Understand of the role of engineers in society
- Become familiar with the different branches of engineering
- Assess their aptitude for engineering
- Learn how engineers use the principles of science and mathematics to solve practical problems
- Be introduced to the design process
- Learn some basic principles of engineering analysis

Since this is a regular college course, it includes homework assignments, exams, a term paper and a design project. We believe that a structured course of this type is much more effective than a non-credit seminar.

The course is organized as follows:

Week 1	Introduction Role of Engineers in Society Branches of Engineering
Week 2	Analysis Methods Newton's Laws Interviews with Practicing Engineers Chemical Engineering
Week 3	Newton's Laws Electrical Engineering
Week 4	Stress Agricultural Engineering
Week 5	Strength of Materials Mechanical Engineering
Week 6	Bridges Manufacturing Engineering Industrial Engineering Bridge Design
Week 7	Engineering Technologists Bridge Design
Week 8	Use of Computers in Engineering Civil Engineering Model Bridge Load Test (Saturday)
Week 9	Review of Model Bridge Load Tests Significant Figures Measurements and Instrumentation
Week 10	Survey of California Engineering Schools Selecting a University CaPSET Solar Powered Car

The bridge design sessions tie in with the design project: building a model bridge using popsicle sticks and white glue. The objective is to design and build a bridge which can carry a large load, yet have a small mass. Each bridge is then load tested to failure and the builders of the winning bridge (i.e. the one with the highest load/mass ratio) receive a scientific calculator as a prize.

At the end of the course we also discuss methods of choosing an engineering school. The course is not intended to be a Cal Poly "commercial" or even a CSU "commercial". Therefore, we have compiled a matrix which lists all of the engineering schools in California, both public and private, along with the degree programs offered at each school. The matrix also indicates which programs are ABET accredited. Thus, once a student has selected an engineering discipline, he/she can easily determine which universities offer that particular program.

Although we do not make recommendations regarding which school to attend, we do attempt to give the student the necessary tools to evaluate a program. This includes discussions of ABET accreditation, university facilities such as laboratories and libraries, and other relevant issues. We also encourage the students to visit prospective campuses and meet with the faculty before making a final selection.

Since the students in this course receive college credit, they also generate FTE and the associated funding. This, when combined with the student enrollment fees, will pay for the expenses of offering the course.

Thus far, this course has been offered three times: in 1986, 1988 and 1990. Each time it has been very well received by both students and high school administrators. We have even had the board of education from one school district view one of the classes. As a result, Cal Poly has subsequently offered other career guidance courses in science, business and teacher preparation.

The Use of Satellite Networks

In 1988 we extended the network to include satellite connections with a number of schools outside the Los Angeles Basin. These were primarily rural schools which typically have limited course offerings. Satellite time is available for $350 to $400 per hour, so this type of network can be economically viable if enough students can be brought on-line.

Possibilities for the Future

As far as we know, Cal Poly is the only university in the nation to use distance learning to teach pre-engineering to high school students. We have demonstrated that this technique is both workable and cost effective and encourage other universities to develop similar programs. The CSU campuses seem to be especially well suited because of our emphasis on undergraduate education. The following CSU campuses have both a college of engineering and an ITFS program

and thus could easily offer a similar course:

- Chico
- Fresno
- Fullerton
- Long Beach
- Los Angeles
- Northridge
- Pomona
- Sacramento
- San Diego
- San Jose

Another possibility would be a group effort involving two or more CSU campuses linked via satellite. Chico and Sacramento have already done this for other courses.

References

1. "Supply-Side Labor - The Next Competitive Crisis", *Research and Development*, Vol. 31, p. 16, May 1989

2. "U.S. Faces Potential Shortage of Engineers", *Aviation Week and Space Technology*, Vol. 129, No. 23, p. 36-41, Dec. 5, 1988

3. "Engineer Grad Numbers Still Declining, New Survey Says", *ASCE News*, April 1991

4. "Engineering Societies Launch Largest Sector Voluntary Effort in Support of Education", *ASCE Los Angeles Section Newsletter*, May 1991

Computer Solution Of Engineering Problems

Donald E. Kirk
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Artice M. Davis
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San Jose State University

Abstract. An experimental freshman course emphasizing engineering problem solving using computers is described. The course features a high level structured language (Pascal), a user-friendly development environment(Turbo Pascal), and the DOS operating system on PCs. One of the goals is to stimulate student enthusiasm by exposing them to what engineering is and what engineers do. A mechanism for accomplishing this is through the use of open-ended *explorations* in which students develop the ability to learn on their own by posing and answering "what if ... " questions. A second goal is to reinforce, through engineering applications, concepts of math, physics and chemistry students have learned in other courses. Laboratory exercises have been developed using an "open course architecture" -- faculty from the various engineering departments have contributed and assisted with the development of ideas for problems appropriate for computer solution and illustrative of their discipline. These laboratory experiments are described and a preliminary evaluation of the experimental course is presented.

The Current Situation

At the present time, SJSU engineering students take the lower division course ENGR 050, Introduction to Computing. This course uses FORTRAN 77, is taught with two lecture hours and no lab hours, and relies primarily on textbook problems solved on a mainframe computer. This is one course of a group of three that have been under scrutiny recently, and there are several concerns. Present day computing is most often done in a PC/Workstation environment using a structured programming language. While the choice of a particular language is not critical, it is desirable for a first exposure that the language be at a relatively high level, and that it provide a good lead-in to Ada and/or the C programming languages for some disciplines. In addition, engineering departments have long noted the need for an earlier introduction to engineering to overcome the attrition that often occurs in the first two years when students traditionally study little but math and science foundation courses. Finally, it is important to reinforce the fundamentals of math and science through problem solving using meaningful engineering applications.

Goals

The goals established in the experimental course offered in the School of Engineering at San Jose State University during academic year 1990-91 were to:

1. Develop proficiency in using a personal computer, an operating system, a high level structured programming language, and a development environment;

2. Learn to do top-down design;

3. Gain knowledge of what engineering is and what engineers do as a way of providing excitement and enthusiasm about engineering;

4. Develop the ability to learn on one's own through explorations by posing and answering "what if ... " questions;

5. Reinforce the fundamental concepts of math and science through engineering applications; and

6. Learn teamwork.

The Experiment

The course has been offered for two semesters in three slightly different formats. In the fall 1990 semester two special sections of ENGR 050 were team taught. Four laboratory sessions were staffed, but students were not required to attend because the course had no official laboratory credit. In the spring 1991 semester, the plan was to offer two sections of the course as ENGR 096 with one lecture hour and three lab hours per week. There were to be two lab sessions available for each lecture section. As a result of scheduling problems, only one section of ENGR 096 was offered. A second experimental section of ENGR 050 was also taught covering much the same material, but again without an official lab session. In all of these offerings, the lectures were devoted primarily to Pascal with frequent demonstrations using a transparency projector equipped with a liquid crystal display unit to project the screen of an IBM PC equipped with Turbo Pascal. The laboratory sessions featured the use of DOS, Turbo Pascal's Integrated Development Environment, engineering-based problems and explorations. The lecture topics were: Introduction to computers and operating systems; Introduction to Pascal; Data structures and control structures; Procedures and functions; Arrays and matrices; Records and complex numbers; and, Object oriented programming. Table 1 contains a list of the laboratory experiments developed and assigned in the three sections.

Table 1: Laboratory Experiments

ENGR 050 Fall '90	ENGR 050 Spring '91	ENGR 096 Spring '91
1. DOS*	Van der Waal's Equation -- An Incinerator	DOS*
2. Introduction to Turbo Pascal's Integrated Development Environment	Period of a Nonlinear Pendulum (Numerical Integration	Reading/Writing using Turbo Pascal*
3. Reading/Writing using Turbo Pascal	Random Numbers and Encryption	Baseball Kinematics*
4. Baseball Kinematics	Matrix Procedures	Hooke's Law*
5. Sequences and Derivatives	Complex Numbers and Units	Random Numbers and Encryption*†
6. Graphics		Matrix Procedures *†
7. Matrices and Spacecraft Control		Spacecraft Control *†
8. Complex Numbers and Units		

* Features explorations
† Team Projects

Demonstrations, developed to illustrate the programming concepts, are listed in Table 2.

Table 2: Demonstrations

Reading and writing

User defined types, such as enumerated and record types

Control structures: While, Repeat Until, For, If, Case

Top-down program design using procedures and functions

Scope, visibility and parameter passing

Arrays: one- and two-dimensional

String manipulation: exploration of the IBM extended ASCII code

Graphics: Detection of type of graphics card, graphics initialization, various graphics primitives and concepts

Data files

Type coercion (or "Type Casting")

Object oriented programming (Graphics)

The concept of explorations was introduced to bring student initiative, creativity and excitement into the learning process. During the spring '91 semester in ENGR 096 the following explorations were assigned:

1. DOS -- Learn to use a "new" (i.e., not discussed in class) DOS command, such as SORT or XCOPY;
2. Reading/Writing -- Investigate what happens when Read(X1,X2) and ReadLn(X1,X2) are used with the input data entered as X1 X2 <Enter> or X1 <Enter> X2 <Enter>;
3. Hooke's Law -- Find the maximum stress that yields a saleable product;
4. Random Numbers and Coding -- Explore the operation of the random number generator and develop and test a new encoding/decoding scheme;
5. Spacecraft Control -- Determine characteristic behavior for various values of velocity feedback and select a value for acceptable performance.

Results and Future Directions

The authors' evaluation is that the experiment has been a qualified success. Some students learn a lot and show great enthusiasm; others seem only to "go through the motions". Some students feel that the amount of work involved is too much for a two-credit course. This complaint, however, is not unusual in first computer courses. Some of the explorations have generated enthusiasm and interest, while others have been perceived as just another

requirement to be met. Thus, the explorations concept needs further development and evaluation. Cooperation from other faculty has been very helpful, and this involvement will be essential to provide new and improved laboratory assignments. Another objective is to provide more exercises and explorations that the students consider to be fun. An immediate goal is to provide graph plotting that works reliably over the network in the PC lab. Many laboratory exercises under development require this capability.

In the future, an effort will be made to give more formal consideration to teamwork. So far, some projects have been done individually and others have been joint efforts (in ENGR 096). Surprisingly, students initially resisted working as two-person teams on projects. Student resistance and academia's emphasis on learning and performance as an individual may explain industry's observation that engineering graduates often must learn interpersonal and organizational skills to function effectively as members of a team. Finally, a longer term goal is to develop a course on engineering problem solving using software packages, such as a spreadsheet, database program, and equation solver. Many powerful packages are now available, and students could benefit both in their engineering studies and after graduation by being proficient with a reasonable set of these tools.

A WORKSHOP IN ERGONOMICS & ENGINEERING DESIGN FOR HIGH SCHOOL/PRE-ENGINEERING COLLEGE STUDENTS

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Abstract

Predictions have indicated a shortfall of over 500,000 engineers in the next two decades (Engineering Manpower, 1989). The purpose of this paper is to propose a motivating workshop in Ergonomics and in engineering design for students who may further consider enrollment in an engineering program if their interest was effectively risen. The objective of the workshop will be to introduce the subjects of Computer Aided Design, Human Factors Engineering and Principles of Engineering Mechanics and general design guidelines to the students. A real life problem such as design of interior of a car, or a control panel of a certain control room could be presented to them for evaluation. The students will be asked to apply the guidelines of the subjects studied and propose a redesign of their project. Assignments could be given to teams of students to encourage further enthusiasm and team work.

The workshop could be designed for a one day, weekend or a summer week duration. A similar program was previously provided successfully by the University of Idaho. They have indicated an overwhelmingly positive response by the student attendees. The workshop should be designed to be motivating, hands-on and actually show how a product is evaluated from the engineering perspective. The students could take away a hardcopy of their own final design of their products as rewards.

Introduction

Several sources have compiled statistics on demand and supply of engineering professionals and they indicate a trend that shows a decline in the number of students attending engineering schools (Engineering Manpower, 1989). This added to attrition rate due to retirements of present engineers has researchers believe that shortage of engineers could exceed 500,000 by 2010 (Wales, 1989). Although there could be numerous factors contributing to the decline, the author believes that lack of interest in sciences and lack of smart marketing are the major factors in this situation. These factors were also reported previously to be of the most influential causes of resistance to the field of engineering.

This paper will present two programs, one designed at Cal Poly, Pomona and the other at University of Idaho, both made of the same elements which were tested and proved to be successful in recruiting pre-engineering and high school students to become engineering majors. The basic elements of both programs are human engineering (Ergonomics) and engineering design using computer aided design. The programs are designed to be hands on, motivating, encourage team work, and yield in a tangible design. Although the research for the programs may not be scientifically valid, process of engineering design was followed to ensure maximum possible learning.

I. Cal Poly Pomona's Workshop Designed for Minority Engineering Program (MEP)

The industrial and manufacturing engineering (IME) department was asked by MEP to allow for a tour of their laboratory facilities by about 1000 high school minority students. The time limit was two hours of a Saturday when all students were attending to become familiar with the Engineering School.

IME faculty designed a program which was to be motivational, user friendly, yet engineering oriented. The program was a hands-on introduction to human engineering in design and computer aided design. Computers were used by the participants throughout their tour.

Human engineering was selected in order to show students the application of science in their daily life. As an example, a software was provided which measured participant's reaction to sound or visual cues. For the students it was firstly a video game, but after the game was over they were asked where they would substitute visual displays for auditory displays or vis-a-versa. Further they were asked how they could incorporate their results in designing a more user friendly VCR.

Computer aided design was primarily used to reduce any fear of technology. A program provided by Auto CAD namely SOLAR was used for presentation purposes. Participants used a mouse as an input device to start from the universe and search for earth, moon, the lunar lander, and finally a plaque that is situated on a leg of the lunar lander which could be read by the students. With adequate time students can continue in learning to draw circles and rectangles on the screen and then go on to present a design of a VCR using Auto CAD. A hard copy of their design could then be presented to them for keeping.

The attraction to the program was to the point that it was extended from two hours to a full day.

II. University of Idaho High School Summer Workshop

College of Engineering and Department of Psychology at the University of Idaho cooperated in designing a program for high school students. The program was in a two week workshop format during summer vacation. Short courses were offered

to students to develop and improve their basic technical skills. Subjects taught were still human engineering and engineering design in form of graphics. Participants were responsible for working in teams and proposing redesigns for products and systems such as operator control panels used for locking vessels through the lower Granite Dam on the Snake River.

They had an average of 70 participants in the last two years, about 30% women and 11% ethnic minorities. The program was supported by tuition which included room and board for two weeks, and grants from the US Department of Energy. They reported over 50% of the students returned to the University of Idaho's College of Engineering and for the last year, in an exit survey, 85% of the participants expressed their intent of enrolling in their engineering school. Their evaluations also indicated that more emphasis should be put on Human Engineering.

Conclusions

Studying the success of the two programs mentioned in this paper, in addition to remarks made by other researchers, one would conclude that students could get interested in engineering if certain factors are combined in marketing the subjects. These factors are believed to be:

a. Motivation through hands-on practice. The degree of motivation could go as high as absorbing students in the field as in addiction.

b. User friendly approach to application of science in engineering. This can be done by introducing more lab oriented courses in freshman and sophomore years. As an example "Egg Drop Contests" have been practiced by many campuses during certain functions. However, when games are over, no one tries to explain why the winner's design worked better than those designs that lost. Such contests could be presented to pre-engineering students and science and engineering process could be related to them as students are put through an enjoyable journey through engineering.

c. Cost effective for universities and yet inexpensive for students seem to be factors that go hand in hand in such situations. Industry and government agencies seem to be aware of the future shortage of engineers and thus they could provide the needed grants or environments where such programs could survive.

d. Human Engineering and Computer Aided Design are two subjects that, adequately applied, are interesting to pre-engineering students.

In summary, innovative programs in teaching engineering are greatly in need at the present and approaches such as programs explained above seem to be a realistic way of encouraging more students to the fields of engineers.

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An Introductory Engineering Course to Provide Skills and Motivation

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This paper describes a course proposal to attract and retain students in the engineering program. The proposal is broad enough to give some exposure to all the areas of engineering but the intent is to focus on electrical engineering. It has been suggested that over the past few years fewer students are opting for an engineering degree. At the same time a number of the students at the lower division level are dropping from the program without ever enrolling in an engineering class. We hypothesize that a class which introduces students to laboratory concepts and equipment early in their academic career would not only provide motivation to remain in the program for the science and mathematics courses, but may improve later laboratory performance. We are suggesting a course that introduces the student to engineering studies using the skills of the beginning college student. The course would begin with problem solving methods and then would expand to cover a few selected engineering topics. The computer could be used extensively and in some cases it could be used for tutorials with menu driven programs. At California State University at Sacramento one laboratory is equipped with a General Purpose Instrumentation Bus. This laboratory could be used for an experiment that is menu driven to show the capabilities of that laboratory, and give an introduction to electrical engineering that would stimulate interest and desire for the curriculum. Other laboratories could be introduced in similar ways. The purposes of this course are to introduce and provide engineering skills to students, as well as to motivate students to achieve in pre-engineering courses.

There are a number of good reasons for establishing an engineering course for the first year college student. This course would help students to better understand the engineering field, give them motivation for taking all of the prerequisites for future courses, and help them to decide which branch of the discipline they desire to pursue. It would also provide identity with the

engineering school and provide a connection with engineering faculty in each of the departments for counseling and advising. The course would have no prerequisites so that it would be open to all majors and thus provide a means for other students to consider the engineering field for a career.

While this course is an introductory course with the primary intent to give an overview, it could also provide some fundamental skills that would be helpful to students continuing in engineering as well as other fields. The primary focus would be problem solving. The course should be fun. With that intent, games and puzzles could be used to introduce more structured techniques of problem solution. The course would not only contain a laboratory section, but would be centered around the laboratory. Again the laboratory exercises would be chosen for their value in introducing the various areas as well as providing motivation for pursuing the engineering field. A number of faculty could be invited to share in the teaching to accomplish the joint purposes of introducing the breadth of engineering as well as getting students acquainted with a number of the faculty. This contact with faculty would help the student to more readily seek advice from the faculty in their choices for course work and career. The lectures then would provide background for each of the laboratories. Four laboratories are suggested to accomplish the purposes given; others could be included. The laboratories suggested are General Purpose Instrumentation Bus, Robotics, Materials Testing, and Signal Processing.

The General Purpose Instrumentation Bus laboratory would introduce students to the electrical engineering program and acquaint them with a laboratory that is advanced and powerful. In this laboratory they would perform a very simple experiment of lighting a light bulb with different voltages, but controlled by a computer with the data stored by the computer and finally printed on a graph on the computer's printer. Having been given all of the instructions necessary to accomplish this, students would find this easy to do and instructional as they could easily visualize the capability of this equipment in more advanced experiments. The students could then be challenged to make the computer do other things by modifying the program given to them. These tasks would be relatively simple so that the modifications are minor but very instructive from a problem solving standpoint. This would provide opportunities to discover by trial and error how the original program given to them works. Many students at this level will have the skills to add variations. It would be important to challenge the

more advanced students while keeping all the students involved. This laboratory would then provide basic understanding of electrical engineering while providing fundamental skills and motivation.

The Robotics laboratory from just the name motivates students through the images that are brought to mind. The computer attached to the robot arm is fascinating and challenging for the student. While this is a senior level course for the regular curriculum, it is a good example of how very advanced course work can be modified to introduce students to the areas they will eventually be studying. It is simple to show students how to manipulate the arm with the computer. A lot of problem solving situations can then be devised to demonstrate the types of engineering which need to be done in this area. A simple problem such as the collision of one robot arm with another in the same workspace provides a challenge. The robotics field shows the need for coordination between the disciplines of mechanical and electrical engineering. A task that can be assigned which would generate a lot of interest and enthusiasm is that of requesting each student to design a demonstration routine for the robot. This allows for differences in skill level and also allows students to exhibit creativity. This laboratory is always fun no matter how difficult and provides a high level of motivation.

The materials testing laboratory provides the student with a means to experimentally confirm some basic theory. Simple tension and compression tests on different types of steel could be done and perhaps compared with a few other materials. The classic testing of concrete samples made by the students is a possibility. A laboratory that provides fun and motivation is one in which the student is asked to design and build a structure in competition with the other students. The structure must be built with constraints on materials and dimensions and is then tested to failure. There is an opportunity in this laboratory to show the application in engineering of the mathematics from courses that the student would be currently enrolled. This type of experiment provides a very graphic means of illustrating the trade-offs that almost always occur in engineering design. In this laboratory students would use equipment that is very practical at a level similar to its use later in the engineering curriculum. These experiments and reports would begin instruction for careful data recording and report writing. This laboratory should be enjoyable and rewarding while providing some excellent instruction in engineering skills.

The signal processing laboratory has equipment that allows digital signal processing to take place with an analog input and output. Software makes possible the acquisition and inspection of waveforms from a digital oscilloscope. A segment of a waveform of any length can be recorded to a file and then be replayed continuously. Files can then be modified, for example, by changing the pitch or observing the effects on the signal being filtered. The mechanics of speech can be studied in this laboratory. An interesting experiment is one that records and analyzes speech patterns. Recognition of the different patterns for vowels and consonants provides an interesting way to see how this equipment can be used. Students could have fun with recording and analyzing their own speech while learning some fundamental engineering skills. Another exercise that would provide interest is that of acquisition and analysis of the electrocardiogram. With the ECG lead attached, the individual could monitor the waveform during various activities. The waveform could then be compared to the expected biopotential waveform. The engineering concepts taught in this laboratory would include the components of the digital signal processing system, sampling, aliasing, and filters. This would be done at a level that would encourage participation and provide motivation for the subject.

With this course being designed around interesting and fun laboratories, students would be very motivated and encouraged to pursue an engineering career. While it has been emphasized that the course would be fun, that does not mean that the content would be shallow. These laboratories have been suggested because they provide a high level of participation in tasks that relate to common experiences and provide a high level of visibility for engineering techniques. The major fields of engineering taught on this campus will be introduced using these subjects. It is expected that the introduction of students in the first year to the engineering curriculum would provide many benefits to the student and improve the academic experience.

"An Engineering Orientation Course as a Pre-Engineering Retention Tool"

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ABSTRACT

Minority Engineering Programs (MEP) work both within and outside universities to attract under-represented minority students to Engineering. Retention and matriculation of minority students once they have entered the university is a critical component of such programs. We present here some typical profiles of students entering Engineering programs through MEP; a significant proportion of students have a profile characterized by weak and inadequate preparation in Mathematics and Physical Sciences at the high school level. We focus on this particular group and discuss their needs, expectations and capabilities.

These students are entering universities in an era of diminishing resources and in an environment where the faculty training and capabilities do not necessarily match the needs of such students. One strategy to bridge this gap between student abilities and faculty expectations is through offering an Engineering Orientation course.

We discuss our experience with an Engineering Orientation Course for pre-engineering minority students in terms of course content, assessment of outcomes, and possible modifications to the course content and format which may enhance its effectiveness.

Minority Engineering Programs (MEP's) within the University of California (UC) and California State University (CSU) systems employ a mature and successful retention model. The retention model supports MEP's mission, to increase the number of Afro-American, Hispanic American, and Native American engineers graduating from our universities. MEP retention efforts throughout the state employ the model's three basic components, 1) an academic/study support center, 2) an MEP staff which creates an environment of belonging and high achievement, and 3) an engineering orientation course. Our Engineering Orientation course, Engineering 111 (ENGR 111), is a means of acclimatizing new MEP students to the university environment and the rigorous discipline of engineering. ENGR 111 also encourages pre-engineering students to remain committed to the extra years they will need to earn their Bachelor of Science degrees.

MEP Student Profile

Most of our MEP students are educated in the local bay-area public schools. Given that few public high schools offer Calculus, Chemistry and Physics to their seniors, MEP usually receives students directly from high schools who are ill-prepared to begin the engineering curriculum. These students and others who reach the university with inadequate background in math and science belong in the "pre-engineering" category. Currently, over forty percent of all our MEP students begin their studies at the university in pre-engineering and general education courses. A profile of our typical "pre-engineering" MEP student is based on the following aspects : age, sex, economic background, and prior education.

Age Grouping

MEP's pre-engineering students typically come in two groups; those aged 25 and over (older students), and those younger than 25. The older students are often more mature and highly motivated. Several of them have already tried disciplines other than engineering, and have decided that engineering is either a desirable second degree or the degree of choice. Many of the older students are supporting families, all are working 30 hours or more a week in a variety of jobs. Frequently, these students are employed in technically-related positions and view the degree as a means of career advancement.

The older pre-engineering student usually brings a long term view to the process of completing the degree program, and has an accurate assessment of his/her math and science strengths and weaknesses. Sources of MEP's older pre-engineering students include 1) local Community Colleges, 2) other degree programs at the university, 3) transfers from other colleges and universities, 4) Re-entry programs, and 5) part-time students interested in completing an engineering degree while maintaining their full-time jobs.

The younger pre-engineering student (17-25 years old) has a shorter term focus than the older pre-engineering student, and exhibits a greater measure of impatience to graduate. This desire to "hurry up and graduate" can be a source of demoralization once the younger student realizes the time investment required to complete an engineering degree. Like most other engineering programs, our engineering curriculum is designed for a full-time student who works less than 10 hours per week, and who reaches the university prepared to begin the basic courses of the curriculum. The profile of the MEP student differs greatly from the profile of the student for whom the typical engineering curriculum is designed. This, in itself, is a source of frustration for the younger pre-engineering student. Sources of younger pre-engineering MEP students are 1) high schools, 2) community colleges, 3) other degree programs on campus, and 4) transfers from other colleges and universities.

ENGR 111 benefits older students in part by acquainting them to the study of engineering and fully outlining the time necessary to complete their degrees. The orientation course also provides them with a forum in which to ask questions which might otherwise go unanswered. Older students usually are not graduates of a "summer bridge" program, as the younger students often are. The older student, therefore, often has basic questions concerning the university and procedures, but no programmed opportunity to pose them outside of such a class. Younger students, on the other hand, are often unsure of their area of interest and need a survey of engineering disciplines and the time to explore each major discipline. The retention of younger pre-engineering students appears to be related to the ability of the student to identify a specific area of engineering interest.

Sex Grouping

An overwhelming majority of MEP students are male, and the pre-engineering students are no exception in this regard. Historically, the pre-engineering female students have out-performed their male counterparts with respect to grade point averages and group leadership skills. But the engineering attrition rate for women is higher than for men, and this is also reflected among pre-engineering MEP students.

Economic Background

Economic backgrounds generally seem closely related to the age of the student. It is convenient to categorize students for economic considerations into the same older (aged 25 and over) and younger student categories used above. The older students typically work 30 hours per week or more, or have other means of financial support. Other means include PELL Grants, GI Bill support, and family (usually spousal) support. This funding picture appears positive until one realizes the risks that older

students typically take when making the decision to pursue an engineering degree; older students are often the principal earners for their families and,hence,put at risk their family's financial well being.

The younger group of pre-engineering students can sometimes depend on parental support. Most often, however, support from family is limited to just housing and food, and such support seldom lasts longer than the first two years of their stay at the university. This means that most, if not all, of MEP's younger pre-engineering students are working 20 hours or more. Financial aid to younger students is critical; without this form of support most of them would not be able to attend classes. This economic consideration often compromises their grades, for students receiving financial aid must take a minimum of twelve units to qualify. Historically, pre-engineering students who work more than ten hours a week find it difficult to maintain a 3.0 grade point average if they are taking more than 10 units per semester. The rules for financial aid seem to encourage their taking academic risks.

Younger pre-engineering students, therefore, are typically taking greater academic risks in order to finance their educations. They do so from a position of relatively weak math/science skills, and will require the best guidance available to ensure success.

Educational Considerations

Pre-engineering students come with two types of educational background : 1) those who lack high school Chemistry and Physics, if not Algebra, and 2) those students who have had good high school math/science opportunities, but whose preparation was weak or has eroded over time. Both groups of students face an additional 12-15 semester units of courses to acquire the requisite math/science background. Because of the prerequisite sequence associated with these courses, this may translate to as many as three to four semesters of real time. These units must be completed before they are truly capable of taking Freshman level engineering courses.

The attrition rate for the first group, those students with poor high school background in math/science, is very high. Over 50% of this group will drop out of the pre-engineering curriculum by the end of the third semester. The role of ENGR 111 in combating this trend can be substantial, as the orientation course provides guidance, motivation, support, and relieves the uncertainty which denies students the "light at the end of the tunnel."

The other group of pre-engineering students, those with poor or eroded math/science skills but who have been exposed to the requisite courses, have a greater chance of success. Their weak point, in general, seems to be their study skills. The engineering orientation course can do relatively little to impact this area. Study habits are best learned by doing, and in our MEP this task is delegated to tutors and study groups.

Student Needs

The profile of the MEP pre-engineering student, presented above, cannot adequately express the nuances of individual cases with which MEP deals regularly. It serves, however, as a useful basis of reference for designing the engineering orientation course from a student perspective. The profile alone is insufficient for this task; one should also take into account the student needs and expectations in developing the orientation course.

MEP perceives the needs of pre-engineering students to be the same as those of other MEP students, but the urgency of these needs tends to be greater. This heightened sense of urgency is caused, in part, by to the academic disadvantage from which pre-engineering students start, the longer time it will take them to complete the degree, and the financial hardships attendant with an extended undergraduate career. Pre-engineering students need, in general, 1) a knowledge of the profession of engineering, 2) an indication that the school cares about their success, 3) comprehensive academic advising, 4) a manageable financial plan and, 5) challenge and professional development.

Many of these needs can be addressed on a regular basis through the conduct of ENGR 111 class time. Some will require special, dedicated class hours devoted to a particular theme.

Student Expectations

Pre-engineering students bring expectations to the university which are not always valid. Also, some valid expectations brought to the engineering curriculum are not adequately met. This is the basis of a potentially damaging disillusionment, which cannot be avoided and is arguably a necessary part of one's education. The manner in which the realities are presented, however, is critical, and ENGR 111 is a powerful means of presenting these realities so as to promote a positive outlook.

Pre-engineering students expect to graduate in four years. They initially feel that summer sessions are a realistic means of "catching up" to their engineering student peers, and see no problem with taking 18 or 19 units per semester to make up the time. This is a dangerous, potentially fatal academic plan; it can kill a pre-engineering student's chances of surviving the first critical three semesters with an acceptable grade point average. An orientation course, such as ENGR 111, may be a good place to persuade the students that it is better to graduate in seven years with a 3.0 GPA, than to graduate in four with a 2.0 GPA, or not graduating at all.

Pre-engineering students expect to be treated with respect by instructors, i.e., they do not want to be told that they are either "under-qualified" or that they should not be in a particular

course. They have accepted the risk of failure, and desire to prove their worth. This could portend trouble if they encounter an instructor who will not review material which should have been learned in pre-requisite courses.

Pre-engineering students also expect to be graded "fairly" by instructors. Often this is a more difficult problem than it first appears, because these students feel that they have put in a lot of time into the course and that the grade does not reflect the time they have spent on the course. They often have trouble dealing with the fact that the instructor really does not seem to care that they are working harder than they did in high school. The root problem here, again, is that the student expectation contradicts the faculty attitude that only the result, not time spent, is graded; that "Fair", at the university level is, in its purest form, an objective principle.

Pre-engineering students expect the university to be cognizant of their special problems and expect that the university would be able to assist them in some form with their financial problems. A harsh reality awaits those students who harbor such illusions.

Pre-engineering students expect service; they do not expect to have to go out and teach themselves. They value in-class time with instructors, and instructor availability to answer questions; they also expect mentoring, encouragement, and reward for their efforts.

Faculty Perceptions

Student needs and expectations are, in many cases, balanced by faculty capabilities and perceptions. Faculty members are as varied a group as the pre-engineering students, with the added dimension that a significant percentage of engineering faculty are foreign-born. A look at the faculty perceptions of pre-engineering MEP students, and the ability and training of the faculty to cope with the needs of these students is of interest, for these are areas which most seriously impact the retention of pre-engineering students. The engineering orientation course can help counter some of the detrimental effects of negative faculty perceptions and to sensitize students to faculty view points.

Faculty members are most challenged by their pre-engineering students, as these students often demand the most of their teaching skills. This in itself is not a problem for those faculty members who feel a commensurate reward for conveying knowledge. Those faculty members who feel pestered by the student who asks more questions in class will take the challenge of the pre-engineering student as a thorn in their sides. There is no reason why a faculty member should have to place an extra emphasis on material simply because the student is enrolled in a pre-engineering track; pre-requisites are stated and either met or not met. If a student is not prepared to study at a certain level, why make the extra effort to remedy the situation?

This argument would be valid in a society which has all the engineers it needs, and maintains universities to screen out those aspirants not truly deserving of technical degrees. MEP's, however, exist in the real world of declining overall engineering enrollments, and a crisis of qualified engineers of color in industry. Universities sponsoring MEP's have demonstrated that, in the long run, a student's desire and drive are the final true pre-requisites. Such institutions tend to do what it takes to train next generation of engineers, and are led by f.culty members who will occasionally stoop to reviewing remedial material if it results in student success.

While many faculty are very supportive of the MEP programs, it is also true that pre-engineering MEP students are often viewed quite negatively by significant numbers of engineering faculty. Following are some of the commonly heard negative comments:

- Students are not really ready for the course(s); they need to take the pre-requisite course again.

- Students do not approach the faculty with their academic problems until it is too late.

- Students do not work hard enough.

- Students are not "paying attention" to the important aspects of the subject.

- Students are not punctual with their assignments.

- Faculty simply does not have the time to give the students the individual special attention that they need.

- The students simply do not belong in engineering.

- The "star student" (especially in the case of MEP students, for some reason), is the standard of performance and comparison.

These faculty perceptions are not universal and they are not held by faculty at all times, but they do represent some of the attitudes towards pre-engineering students which negatively affect student performance and retention. Other factors, including faculty capabilities and the university environment figure prominently in determining student performance.

University Context

The context of the pre-engineering student's education is changing, perhaps faster than faculty and administration can keep pace. We are experiencing decreasing financial for both individual students and departments. Equity programs, such as MEP, have also experienced reductions in budgets and expect significant reductions in the future. This occurs at a time when MEP enrollments are

growing dramatically, in contrast to those of engineering schools nationwide.

Recent budget cuts mean that classes are over-crowded, or are simply unavailable, to many students. Faculty positions have also been cut, increasing the work loads dramatically. Frankly, faculty members in engineering departments are overworked. This combines to limit access to the engineering education which we in the CSU system exist to provide. Couple this with the "commuter campus" status of most CSU system schools and the work requirements of our students, and one begins to perceive the difficulty in forming student study groups. This is significant, for as engineers we realize the importance of team work both at the university and professional levels.

ENGR 111 : ENGINEERING ORIENTATION

Given the present environment, there is arguably a need for an engineering orientation course offered to all incoming engineering students, not simply MEP students. But, for now, the orientation course is offered only by the MEP. The structure and content of the course are flexible, yet must address the issues of student perspectives, faculty capabilities and perceptions, and the university environment. Not all of the concerns identified thus far can adequately be addressed through ENGR 111, and measuring success still presents a challenge. An overview of the Engineering Orientation course will illustrate these points.

The mission of the course is to prepare new MEP students for study in engineering and to increase the likelihood of their retention. Throughout ENGR 111 three themes are taught, forming the basis of the syllabus. Traditional lecture, discussion, examination methods are discarded in favor of readings, discussions, guest speakers, and presentations.

The first theme is survival as an engineering student at SFSU. MEP recognizes administrative and academic concerns which will be crucial to the student's well being. Some examples of administrative concerns are the Division of Engineering policy on withdrawing from classes, adding classes, amending incomplete grades, ensuring the accuracy of transcripts, etc. Students must be administratively aware in order to safeguard their grade point averages, but often neglect the administrative concerns out of ignorance of the system. MEP calls a failure to take care of oneself administratively "felony paperwork", and begins instruction on academic advising with a segment on administrative self-preservation.

The second theme of ENGR 111 is the profession of engineering. The instructor uses texts, magazine articles, and current affairs information as the basis of readings. The readings cover the three engineering disciplines taught at SFSU and Computer Science. By the end of the semester, ENGR 111 students have read about Civil,

Mechanical, and Electrical engineering, and can converse knowledgeably on these areas. Readings are reinforced by class discussions, sometimes led by professionals currently practicing in the field being studied.

The third theme is professional development. This is designed to emphasize teamwork as a means of problem solving. An associated sub-theme is preparation for resume writing and interviewing. The professional development theme is approached in a group project concept, in which the class is typically divided into three or more small groups and assigned a project. Each group works independently to solve the problem, and will present their solution to the problem before the class. Group problem solution presentations are the only graded exercises during the semester. Four graded projects are given, each emphasizing a different engineering or computer science discipline. Presentation skills are taught and critiqued, and the emphasis is on in-class work so that the instructor can guide students as they work. Each presentation is complete in that graphics, read-ahead packets for the audience, and role-play are required. The instructor increases the level of difficulty of the assignments as student skills increase.

The class size is usually small enough to facilitate a high degree of personal interaction between student and instructor. More than 20 students, however, would tax this concept unless a senior MEP student could act as an instructional assistant. In the two or three meetings a week format, there is enough time to emphasize the themes outlined above. The retention effect upon pre-engineering students is collateral, for the syllabus does not specifically differentiate between students prepared and not prepared to take engineering courses. Much of the interdiction of future problems is accomplished during the normal conduct of the class.

Below is an excerpt from the syllabus for ENGR 111 as it was taught in the Fall of 1990.

MTG #	TOPIC	ASSIGNMENT DUE
1	Tactics for Academic Survival	Purchase Text
2	Professional Dev. Workshop	Kemper, pp. 1-13
3	Project Time	Kemper, pp. 13-28
4	Guest Speaker	N/A

The three group projects assigned during the semester were due during meeting numbers 17, 24, and 38, with make-ups held during meeting number 40. The problems assigned were:

 # 1 - "Bridge 19th Avenue." A Civil Engineering project involving traffic and safety planning. Focus is on options development.

#2 - "Mark and Modine's Power Press Gym." An Electrical Engineering project with costing and estimation. Emphasis on feasibility.

#3 - " San Francisco Bay Problem." An engineering management project involving both costing and cption considerations. Emphasis is on presentation skills and quantitative methods for decision making.

The Problems of Pre-engineering Students and ENGR 111

ENGR 111 allows for a scheduled time and place for MEP students to see and talk with their program director, who is also the instructor for this course. Consequently, student concerns are usually brought to the director's attention and his energies are systematically focused at the point of greatest need, the pre-engineering students enrolled in ENGR 111.

Pre-engineering students receive the direct word from the instructor concerning the environment they face and what is expected of them. The instructor takes great pains to disabuse pre-engineering students of the "four years to graduation" ideal held by many. News on financial aid, potential employment in engineering, study and tutoring groups, and personal mentoring, etc., all become part of class discussions. The class discusses concerns collectively; there are days when the material is covered early and free-form discussions range through several topics. A process of socialization takes place thereby, friendships are formed, and students learn to count on people who will share a long common road to an engineering degree.

Despite these attempts, not all student problems can be addressed in ENGR 111. Attitudinal problems, lack of commitment, ambivalence and immaturity are as common to the pre-engineering students as they are to all others. These problems are not truly addressed in the course. Besides a sharp reprimand or a sincere "heart to heart"talk, there is little the instructor can do to resolve these problems. The point, however, is that the instructor must try. The syllabus should be seen only as a starting point and guide, and not as a delimiting set of rules.

Measuring Results

Results assessment is currently the weakest part of ENGR 111. To date, the course has only been taught at SFSU twice. We feel that the ultimate measure of success is student graduation rate, but we are working on developing other methods of tracking success short of a five or six year wait.

Other methods include periodic reviews of the grade reports, using MEP students who did not take ENGR 111 as the control group. Considering each ENGR 111 class as a cohort, compare the

matriculation rates, and grades in calculus, chemistry, and physics for each cohort to that of other MEP students. This can be an indicator, for if ENGR 111 made a positive difference, these early prerequisite courses will show it.

Another short term measure of success involves faculty feedback. Each MEP student has a faculty advisor; this professor is in a position to comment upon the reletive strengths/weaknesses of their ENGR 111 graduates versus non-graduate MEP students.

Finally, the MEP staff can review attrition rates of pre-engineering students using the same cohort/control group comparison. We realize that there are more factors involved with attrition, matriculation, and overall grades than ENGR 111. The orientation course, however, should make a significant difference. The comparisons above should make the difference apparent and provide a basis of course critique.

Conclusion

There is much room for creativity in the format of an engineering orientation course, but no better purpose than the retention of MEP's pre-engineering students. Given that some campuses have not provided for an MEP sponsored ENGR 111 style course, there are alternatives which can meet the need at least in part. One such alternative is a well-structured, school sponsored seminar series designed to present lectures on many of the same subjects. The target population can be reached via direct mailings, posters, and/or word of mouth through instructors, but the effort should be sincere.

Another alternative is a comprehensive summer bridge program for incoming students. Topics besides administrative and academic survival at the university, however, may be beyond the time scope of such a program. Finally, another alternative is the assignment of student mentors capable of providing much of the same guidance, but over a longer period of time, as an ENGR 111 course. The difficulty here is in recruiting qualified mentors. More alternatives to the formal course, given the context of the campus, can be explored. But none will replace the effect of a formal course, such as ENGR 111, which evolves to meet the changing environment and student needs.

Introduction to Engineering Design: A Freshman Mechanical Engineering Course

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Abstract- *In the fall of 1990 a new design course at California State University, Chico for mechanical engineering freshman and recent transfer students was offered for the first time. The motivation for creating the course was to encourage students to continue their study of mechanical engineering. The course included three additional objectives: (1) for students to learn a process for designing engineering systems, (2) to give students opportunities to be creative, and (3) to introduce students to the concept of using a computer to control an electro-mechanical device. The content of the course as well as its genesis and an assessment of its success is discussed.*

INTRODUCTION

For the past several years the number of undergraduates majoring in mechanical engineering at California State University, Chico has steadily decreased from 271 in 1986 to 197 in 1990, a drop of 27 percent. This decline in engineering enrollment is not unique to Chico. It is occurring across the nation.[1] According to Lohmann ". . . Of the entering college students majoring in engineering, science, or mathematics, 40 percent drop out after the first year . . ." At Chico, the average retention rate in engineering between the freshman and sophomore years has been 54 percent over the past 15 years.

These enrollment patterns probably have multiple causes and hence the problem is being attacked by the mechanical engineering faculty at Chico in a variety of ways. One approach is an attempt to increase the retention rate by motivating the newest majors to continue their study of mechanical engineering. How can this be done? Do students become "demotivated" by the traditional early years of science and math study? What motivates future mechanical engineers? To answer the last of these questions, the faculty looked at the curriculum and subjectively assessed what topics and activities in the current curriculum excited students.

Prior to the fall of 1990, the first design experience present in the curriculum was a junior level machine design course which included a laboratory in which students designed a computer controlled electro-mechanical device to perform a specified task. The students' designs were then evaluated by having them construct prototypes and participate in a competition. This lab activity had been done repeatedly since 1984. It was perhaps the single feature of the curriculum that students looked forward to and continued to be excited about after having completed the course.

While this project was associated with a machine design course in which extensive analysis is performed to optimize system parameters, few students applied these analytical skills to the design of their electro-mechanical devices. The lecture portion of the course concentrated primarily on the detailed design phase of the design process, i.e., sizing of parts, choosing material properties, etc., and the lab concentrated on the problem definition, conceptualization, and evaluation phases of the process. If the lab activities excited juniors, could it excite freshman? And, more importantly, would it be a realistic window through which to view what engineers do and would it therefore motivate students to continue their pursuit of a degree in engineering?

AN EXPERIMENTAL COURSE IS BORN

In the fall of 1990 a design course for mechanical engineering freshman and recent transfer students was offered for the first time at Chico. The course was patterned after the junior machine design lab. Called "Introduction to Engineering Design", the course emphasized concepts common to all engineering disciplines.

The primary objective of the course was to encourage students to continue their study of engineering, but there were three additional objectives: (1) for students to learn a general process for designing engineering systems, (2) to give students opportunities to be creative, and (3) to introduce students to the concept of using a computer to control an electro-mechanical device.

During the freshman year Chico mechanical engineering students traditionally have taken only one engineering course, Engineering Graphics. To fit this experimental course into an already jammed curriculum, the course was offered as a substitute for the graphics course. Students were told that the design course was not required, but if they chose to take it, they could substitute it for the required graphics course. If the experiment proves successful, the intention is to make the new design course a required freshman course and teach graphics later in the curriculum.

Most of the freshman and new transfer students in mechanical engineering chose to drop Engineering Graphics and enroll in the experimental course. As the maximum anticipated enrollment was 32 students divided into two sections, the 41 students wishing to take the course resulted in a third section being offered.

NUTS AND BOLTS

The graphics course was two units; therefore, the substituted design course was also two units, nominally meeting for one hour of lecture and three hours of lab per week. There were, however, few formal lectures. Rather the class sessions were spent mostly doing exercises in small groups, having class discussions, doing computer exercises, working on design projects, and giving student reports. The class met for two hours two times per week for fifteen weeks.

The course was designed to teach a general process for designing a product. This was reinforced by practicing the process on an introductory project and a major project. As the major project was to design, construct and test a computer controlled device, two major threads ran simultaneously throughout the first portion of the course: (1) How does one generate ideas and go about designing something? and (2) How does one cause a computer to control an external piece of hardware?

Almost all the students had some prior experience using a computer; however, few had any programming experience and none had any knowledge of how to use a computer to control external hardware. Therefore, from the start of the course, a portion of each class session was devoted to teaching a design process and a portion was devoted to acquisition of computer skills which would be used during the later portion of the course on the second project. The computer skills included using the MS-DOS operating system, programming in Microsoft QuickBASIC, and using an IEEE-488 communication interface to control power supplies and relays in a data acquisition/control unit.

The design process was taught using some lecturing intermingled with small group exercises dealing with various aspects of that process (need finding, problem definition, conceptualization, etc.). Individual and small group overnight homework assignments were given to provide opportunities for further practice of the concepts dealt with in class. A two week introductory design project completed in week six solidified many of the ideas discussed in this portion of the course. This project involved using limited materials (a 13" by 16" piece of foam core board, a coat hanger, six rubber bands, etc.) to construct a device to move a one inch cube of wood from inside a two inch diameter circle to outside a two foot diameter concentric circle as rapidly as possible. Among other specifications, the device was to start completely outside the larger circle and be triggered by the course instructor using the gentle touch of the point of a pencil. The three sections had a joint meeting during which a competition was held at which the winning design removed the cube in 40 milliseconds.

The major course project, called "North Valley Nuts", required teams of two to design and build a system to pick "nuts" (ping-pong balls) off "trees" (structures made from PVC tubing and wooden dowels) and deposit the nuts in hoppers at one of three "nut processing plants". Each system was to consist of three parts, a "nut picker", an "electrical interface" (a wiring harness to connect the nut picker to standard power supply and relay conductors), and a computer program to control the system. System specifications required that the nut picker start the tournament inside an "equipment shed" which had a roof about half the height of the highest branches on the trees, the only human communication with the nut picker be visual and via the computer keyboard, and the only motors to be used were those provided by the instructor. At the end of the semester, this project also culminated in a competition between teams from the three sections.

As an effective engineer requires good writing, oral, and graphical communication skills, the course included practice in each of these areas. Students were required to keep a design logbook in which all work done on the two projects as well as all homework and exercises done during the class sessions were recorded. They were also required to make drawings of

their North Valley Nuts design. Three oral progress reports were made on the North Valley Nuts project as well as a oral presentation after the project was completed. After the first project, students were asked to write a brief analysis of how their project fit into the paradigm for the design process presented in the course. A second longer essay was written to demonstrate the student's understanding of the principles and/or process of engineering design and/or creative thinking techniques discussed in one of three books.[2,3,4]

EVALUATION

During the scheduled final examination period students were asked to anonymously answer 24 questions about the course. (There was no final exam.) Generally the respondents indicated that their preparation prior to taking the course was adequate, although some felt their computer background was inadequate. Most students thought it was an appropriate introductory course; however, many felt it was too time consuming. Their solution, however, was not to delete anything from the course, but rather to increase the number of units. The fact that 75 percent of the students wrote that it should become a required course indicates the student perceived appropriateness of the course.

Most students felt that all the course objectives were accomplished. In particular, 75 percent of the students indicated their enthusiasm for studying mechanical engineering increased as a result of the course. However, a more definitive measure of the attainment of the course's primary objective will have to wait until next fall when registration records reveal how many of these freshman return as sophomore mechanical engineers.

THE FUTURE

The course will be offered for a second time in the fall of 1991. Again it will not be required. Based on the retention rate of those taking the course this year and the results obtained after the second offering, a decision will be made to drop the course or making it a degree requirement. To date the future of the course looks bright, but the experiment is not over and the results have not been fully evaluated.

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Technology Based Instruction in Integrated Computer Graphics/CAD

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Abstract

An introductory integrated computer graphics/CAD course is being developed using the authoring system PROPI. We describe a mechanism for rapid development, test and evaluation of a set of interactive modules that can be used for other course material as well. Goals of our project include teaching computer graphics concepts to students of science and engineering and CAD concepts to students of computer science. An introductory overview module currently being developed is meant to be a prototype. It will be used in a special course to be offered during the 91-92 school year. It is anticipated that a set of 16 one hour interactive modules will be developed by the students in the class. The modules developed will be evaluated and modified at a workshop for university, 2 year colleges, and vocational school instructors of computer graphics and CAD to be held during the summer of 1992. Testing of the modules in various schools will bring the project to closure.

Acronyms like "CAD", "CADD", "CAD/D", "CAE", and "CIM" are increasingly part of the engineering experience. Computer graphics is becoming a tool for scientific and engineering visualization. Engineering educators often take extreme positions *vis a vis* computer graphics and engineering graphics. For some, computer graphics is a substitute for engineering graphics while for others it is a tool for design (CAD), manufacturing (CAM), testing (CAT), and drafting (CADD).

The advent of low cost commercial CAD software has dramatically changed the way in which engineers originate and implement designs from initial conceptualization through analysis to production drawings and life cycle costing. There is increasing acceptance of concurrent design methodology. This means the engineering design process is no

longer sequential and is less iterative. The availability of low cost solid modeling software that runs on microcomputer platforms utilizing the Intel 80386 chip makes it desirable for engineering educators to make significant changes to the engineering design graphics/computer graphics/computer aided design curricula. A recent survey made by Juricic and Barr as a part of the "University of Texas Engineering Design Graphics Modernization Project" shows that textbooks currently in use in universities across the United States are still generally based on multiview projections and drafting practices not reflective of the significant changes that have taken place.

Studies at California State University, Fullerton have shown that skills acquired in a traditional graphical communications course in generating orthographic projections, isometrics and obliques do not necessarily transfer to the needed skills required for effective modeling. Additionally, articulation between community colleges and universities has become difficult with the introduction of computer aided design and drafting software into engineering graphical communications courses.

There is an established trend towards a integrated computer graphics and computer aided design course required for undergraduate computer science and engineering students. CSUF has a computer graphics course taught by the Computer Science Department and a computer aided design course taught by the Mechanical Engineering Department. An integrated course is desirable.

Computer science students interested in computer graphics can benefit from an exposure to CAD. With such knowledge they can make use of the capabilities that are found in most CAD packages to support and reinforce study and research in graphics. For example, a CAD package can be used to illustrate concepts and build solid models to be used for experimenting with and learning rendering techniques, or solid models can be built from first principles and then rendered using a CAD package.

Engineers benefit from such a course by being exposed to computer graphics concepts and standards such as GKS and PHIGS. CAD packages provide default values for most of the parameters necessary to render a solid object. An exposure to rendering operations, common for computer graphics students, allows a CAD package user to understand

and choose appropriate values for these parameters. Familiarity with what is involved in a rendering process means that the first time user of a particular CAD package knows what to look for to achieve a desired effect. The concepts are independent of a CAD implementation.

The difficulty in using the traditional lecture format for an integrated computer graphics/computer aided design course is:

1. the lack of faculty who are facile in both computer graphics and CAD.

2. both CAD and computer graphics are equipment intensive.

3. students learn by use of the equipment and software.

It is clear that an alternative format for teaching this material is desirable. The strategy should be directed towards involving both those interested in computer science and engineering. Our approach is to pool individual expertise in CAD (one of us is the instructor who teaches the CAD course) and computer graphics (one of us is the instructor who teaches the advanced computer graphics course). For this reason last fall we sought and obtained CSUF Intramural Grants funding to develop an introductory instructional module. This effort enables CSUF to become a member of the Association for the Use of Technology in Undergraduate Education. The Association is a consortium of public and private universities formed for the purpose of developing and distributing instructional modules.

With the help of two graduate students we are currently developing an introductory module that will be used as an overview of an integrated course and a prototype for a complete set of modules for such a course. A special course scheduled for this fall and next spring will begin with this module. The course is primarily directed towards engineering and computer science students, but should be beneficial for students in the natural sciences and mathematics as well. Specifically, it is of interest to those who want an exposure to the techniques of graphics, design, and visualization. The intent is to enable participants to communicate concepts visually using available technology. Linear algebra is the only prerequisite. Currently students are required to take calculus and a sequence of computer science or engineering courses before any exposure

to computer graphics or CAD. Students are at least juniors before learning about using a computer for creating graphics. We believe that science and engineering students should be introduced to computer graphics and CAD as early as possible. Such a course could eventually be offered in the freshman year.

The course will be taught in a format consistent with the development of 15 additional modules. That is, the material presented to the students will reflect the content and format of relevant instructional modules. Students will be given instruction in the use of the authoring system PROPI for generating interactive screens. The students working in pairs will generate, code and test modules as part of a project associated with the course. This approach, besides providing interactive feedback in the module development process, is also expected to cut down significantly the time required for module development. It is anticipated that by the time of a planned workshop in the summer of 1992 we will have on hand a complete set of 16 modules.

Specific topics include modeling, rendering, emerging standards, including orientation and viewing procedures. Modeling concepts include solid modeling, wireframe modeling, and parametric modeling. Rendering concepts include various reflection models, shading, hidden line/surface removal, ray tracing, radiosity, etc. CAD concepts include levels/layers, blocks, libraries, hatching, filleting, automated dimensioning, etc. These topics will be presented using the solids modeling package SilverScreen and the rendering package RenderMan.

The workshop offered during the summer of 1992 will be directed towards instructors of graphics, CAD and drafting courses. There will be lecture/discussion/ demonstration sessions of chosen concepts followed by laboratory sessions in which participants working in pairs will use, evaluate and test instructional modules to illustrate the concepts discussed. Each module identifies a concept and supplies examples of how the concept is implemented using a specific software. These modules will be designed to be stand-alone so that any one or more can be integrated into an existing course with minimal course modification. The course content will parallel the content of the special course to be offered during the 1991-92 academic year at CSUF. Concepts will be covered, but the approach is practical rather than theoretical. Experimentation is encouraged as a consequence of the laboratory/hands-on

component. The workshop and the content are thought of as practical learning experiences. Theory will be applied. Since there have been successful workshops similar to the one proposed for some few years in Texas, the approach is not entirely experimental.

Participants in the workshop:

1. will learn the use of the authoring system PROPI to generate interactive instructional modules. PROPI has been selected as the authoring system because of its selection by the Consortium for the use of Technology for Undergraduate Engineering Education as a standard.

2. under our direction will use, evaluate, test and modify the instructional modules that illustrate selected concepts in computer graphics and CAD.

3. will continue evaluation and testing of the modules at their home institutions by either using selected modules in existing courses or by offering a course similar in content to the course "Integrated Computer Graphics and CAD".

Each participant will be provided with copies of the revised modules and instructions for their use. Based on individual preferences, needs and appropriateness to the educational setting involved, participants will be expected to test modules at their home institutions. We will submit copies of the modules developed to the consortium for evaluation and use at institutions.

The process of module development offers an alternative method to that being currently used by the consortium members. The focus of our effort is to develop a set of modules that can be used in connection with a specific course rather than focusing on a specific discipline.

This effort is partially funded by the CSUF intramural grants program. Additional support in the form of standards and consultation has been provided by the Association for Technology Based Instruction.

DESIGN OF A MODERN CURRICULUM FOR LOWER-DIVISION ENGINEERING CORE

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ABSTRACT

This study is concerned with the design of a modern lower-division engineering curriculum with a focus on engineering fundamentals. It involves the introduction of engineering design and information technologies as a foundation for upper division courses to build upon. Three lower-division modules are presented here. The first module deals with engineering identity, value engineering, tools of engineering, problem solving, the design process, engineering challenges, ethics and public responsibility. The second module deals with conceptual design, visualization, modeling, analysis and documentation. The third module deals with basic tools and terminologies of computing, computer programming, software packages, data acquisition and applications. All modules emphasize experimentation, project-based activities, team building, engineering applications and industry participation.

INTRODUCTION

The past few years have witnessed a growing need to revitalize engineering education and make it more responsive to societal needs. Several national studies have cited serious shortcomings that call for restructuring of the entire engineering educational experience especially the lower division curriculum.[1 - 6] Among the many important recommendations made by such studies, are the following:

1. Retain the basic elements of mathematics, natural sciences, engineering sciences and analysis.

2. Place more emphasis on synthesis, design, experimentation, problem solving and communication skills.

3. Stress interdisciplinary exposure, management skills, global perspectives, social responsibilities, and preparation for continuing professional development and career long learning.

The College of Engineering at San Jose State University (SJSU) has taken the lead by embarking on a thorough re-evaluation and restructuring of its lower division curriculum. this paper represents a first step in that direction with proposed topics for three modular courses on Fundamentals of Engineering. These courses build on SJSU's well recognized Lecture/Lab mode of instruction and its excellent computing facilities.

A plan to implement the proposed courses is given in figure (1). According to the plan each course will be offered four times on an experimental basis before full implementation.

OBJECTIVES

1. To modernize current SJSU course offerings of Graphic Science, Technology and Social Change, Descriptive Geometry and Introduction to Computing in consistence with national trends and future challenges to engineering education.

2. To emphasize engineering design and integrate computer usage throughout the curriculum.

3. To motivate students and excite them about the engineering profession.

4. To provide a foundation for upper-division courses to build upon.

BASIS

Five months of research involving the following sources:

i. The National Action Agenda on Engineering Education, ASEE.[1]

ii. Literature on current trends in engineering curricula during the last five years.[2-6]

iii. Recent (1987-91) experimental projects supported by NSF grants to: Drexel, Texas/Austin, and Rose-Hulman and other universities.

iv. Interactions with various institutions in California through active participation in the Engineering Liason Committee.

PLAN TO IMPLEMENT
NEW LOWER DIVISION CORE CURRICULUM

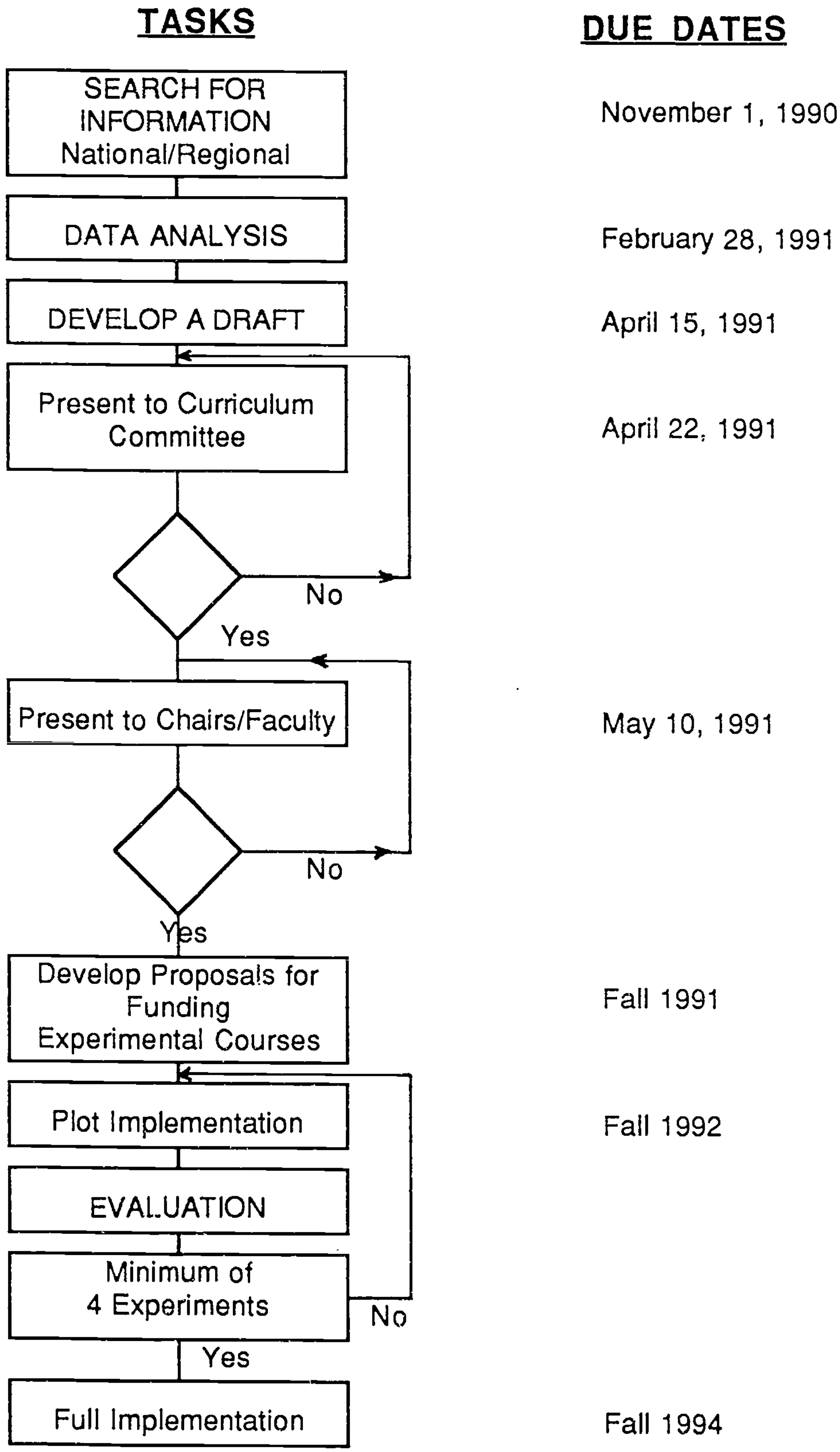

FIGURE (1)

APPROACH

1. A modular approach to the design of three courses with two units each.

2. An instructional Lecture/Laboratory mode.

3. An emphasis on engineering concepts based on a foundation of science and mathematics.

4. Emphasis on:

   Experimentation

   Project Activities

   Team Building

   Applications from various engineering disciplines

   Industry Participation

CURRENT VERSUS PROPOSED COURSE CONTENTS

CURRENT	PROPOSED
Skills Oriented	Based on Science and Mathematics
Differentiated from upper-division	Integrated with upper-division
No ABET Credit	Satisfies the new ABET criterion
Rigid	Flexible

Following is a list of topics for each of the three proposed modular courses entitled Fundamentals of Engineering I, II and III respectively. These courses will be developed according to the plan in figure (1) and offered as experimental courses between 1992 and 1994 before full implementation in Fall 1994.

ENGR 1

FUNDAMENTALS OF ENGINEERING I

CREDIT:

2 units 1 hr. Lecture; 3 hrs. Laboratory

TOPICS:

1. HISTORY OF TECHNOLOGY

2. THE ENGINEERING IDENTITY
   - Multidimensional engineer
   - Knowledge-based engineer
   - Career fields
   - Responsibilities

3. PROBLEM SOLVING

4. VALUE-ENGINEERING

5. TOOLS OF ENGINEERING
   - Computers
   - Statistics
   - Simulation

6. ENGINEERING CHALLENGES
   - The Environment
   - International Competitiveness

7. ETHICS AND PUBLIC RESPONSIBILITY

8. THE DESIGN PROCESS

- Design Philosophy
- Design Methodology
- Impact on:

  Product Function
  Manufacturability
  Quality
  Cost

9. INDUSTRY PERSPECTIVE

- Presentations by industrial experts
- Field Trips

10. TEAM PROJECT

ENGR 2

FUNDAMENTALS OF ENGINEERING II

CREDIT:

2 units 1 hr. Lecture; 3 hrs. Laboratory

TOPICS:

1. CONCEPTUALIZATION
   - Freehand sketching
2. DESIGN VISUALIZATION
   - Projections
   - Computer Aided Design
3. SPATIAL ANALYSIS
   - Auxiliary Views
   - Lines & Planes
   - Angles
   - Intersections
4. MODELING
   - 2-D Layout
   - 3-D Solids
   - Geometric Data Base

5. DOCUMENTATION

   Sectioning

   Dimensioning

   Tolerancing

6. DESIGN ANALYSIS

   Case Studies

7. TEAM PROJECT

ENGR 3

FUNDAMENTALS OF ENGINEERING III

CREDIT:

2 units 1 hr. Lecture; 3 hrs. Laboratory

TOPICS:

1. COMPUTER TERMINOLOGY

   PC, Workstation, Unix, DOS, Resolution, Video Display Networking, . . . etc.

2. BASIC TOOLS

   - Operating System Fundamentals
   - Files
   - Wordprocessing

3. SOFTWARE PACKAGES

   - Database programs
   - Hypercard
   - Computation
   - Analysis

4. COMPUTER PROGRAMMING

   FORTRAN, PASCAL, . . . etc.

5. DATA ACQUISITION

- Concepts and application
- The computer as data acquisition controller
- Measurements and Instrumentation
- Statistical treatment of data
- Process control

6. COMPUTER APPLICATIONS

- Case studies for various disciplines

7. TEAM PROJECT

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