Session 2253

Freshman Electrical Engineering Course
Addressing Retention and Career Choice

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Abstract

The Electrical Engineering Program at the Milwaukee School of Engineering (MSOE) has implemented a new introductory electrical engineering (EE) course in the first quarter of the freshman year. Student retention is the primary motivation, and the special manner in which the course is team-taught helps to ensure the desired student satisfaction. Initial feedback has shown that the students are excited to experience the breadth and flexibility of EE by understanding how familiar, everyday electronic items work[1]. A pass/fail type grading system lessens student first-term stress, while encouraging participation and no-risk experimentation.

Motivation for the Development of the Course[2]

At the Milwaukee School of Engineering (MSOE), engineering freshmen have traditionally been required to take a general engineering course to acquaint them with the various branches of the field, and to excite them about the profession. However, for the EE freshmen, it has become clear that the course's minimal exposure to EE did little to reinforce their career choice. For this reason, the EE faculty set out to develop an EE-specific freshman course, with the primary goal being to improve retention[3]. In support of this goal, several criteria were developed:

- *Introduce EE with the intent of career choice affirmation*[4]. A possible outcome is that the student may decide to change programs. However, it was believed that the majority of students would find their decision to be the correct one, and have added enthusiasm for the program.
- *Acquaint the students with key EE faculty*. No teaching assistants are used at MSOE, so the course would be faculty team-taught, with the goal of having EE advisors among this group.
- *Provide a sense of family within the EE program*. The new students would know who the other EE freshmen are, making them feel more welcome, comfortable, and part of a team during their first quarter on campus.
- *Reduce first-quarter stress*. The pass/fail type grading system would reduce the pressure of grades while encouraging the budding engineers to experiment, with little chance of criticism or fear of failure. That is, show them that *electrical engineering is fun!*

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Structure of the Course

At MSOE, our academic year is broken up into three quarters, each of which includes 10 weeks of classes, plus a final exam week. The course was structured to include both a one-hour lecture and a two-hour lab each week, in weeks one through nine. The purpose of the first week's lecture is to acquaint students with professors and each other, with all four sections of the course meeting in the same room. In Fall 2001, the four class sections included four professors and 58 students. The students were asked to select a partner and join one of four teams (one team per section): *AMPS, OHMS, VOLTS,* and *WATTS*. Those who didn't select a partner were randomly assigned one. In week 10, a common lecture was held for assessment purposes, and that week's lab time was used for make-up experiments. The implication in the above is that all 58 students and four professors had to have the exact same lecture and lab times in common. This greatly impacts the use of lab facilities.

Each of the four professors developed and taught two experiments. Each student team (AMPS, etc.) spent two weeks with each professor, performing that professor's experiments. Students worked with their partner at lab stations, although the experiment performance was sometimes individual (communications, microprocessors). The experiments included:

- **Instrumentation** – all students performed this in week one to familiarize them with the signal generator, multimeter, power supply and oscilloscope in the lab (see Figure 1).
- **Communications** – this two-week experiment required them to build an AM radio from a commercially-available kit that was sold at the campus bookstore. Each student took home the completed radio.
- **Motor and Generator**[5] – Again, a commercially-available kit served as the basis for this experiment where they wound and tested their own motor, assembled the generator, and tested the two. Each student took home these systems.
- **Programmable Logic Controller** – A competition, involving programming an Allen-Bradley SLC 5/02 PLC to perform a specific task, set the foundation for this topic. (Prizes consisted of 0.83 ohm, 20 watt, Milwaukee Resistor power resistors).
- **Logic Devices** – This introduction to digital logic required each student to construct a simple timer system with 7-segment readout.
- **Biomedical Signals** – The purpose of this lab was to show the use of sensors, transducers, and data acquisition and analysis.
- **Microprocessors** – A topic that could be overly complex was made simple and exciting through the use of a Parallax® Basic Stamp® system. Students understood the BASIC language immediately and in some cases went beyond the minimum requirements.
- **Digital Audio** – Laptop software provided the platform for experiments in sampling audio, aliasing, filtering, special effects, MP3, etc.

Each week, the lecture introduced the concepts and helped them set up any laptop software necessary for the lab. As the students rotated between the four professors every two weeks, they experienced the professors' specialty areas, connected with the professors (and EE advisors), and experienced different teaching styles.

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The students were required to attend every lecture and every laboratory, and perform additional work if classes were missed. If a student missed a lecture, he or she was required to write a paper on that topic. If a student missed a lab, both the missing lab work and a lab report were required. Students meeting all requirements would receive an “A” in the course for two (quarter) credits; otherwise they’d receive an “F”. Originally, the intent was to assign a “P” (pass) instead of “A”, and assign two credits. However, this last choice was not possible with the university’s current grading database system, so the alternative process was used. It was decided that if the students did everything asked of them to the level demanded, a two-credit “A” was appropriate. Only two students failed the course. The student reaction to the policies was positive. They had no complaints, and their enthusiastic behavior was testimony to the fact that they liked being able to experiment and try new things in the lab unhindered by the fear of failure.

The course is not set up as a prerequisite for any other course – a deliberate decision meant to allow maximum flexibility in achieving the course goals.

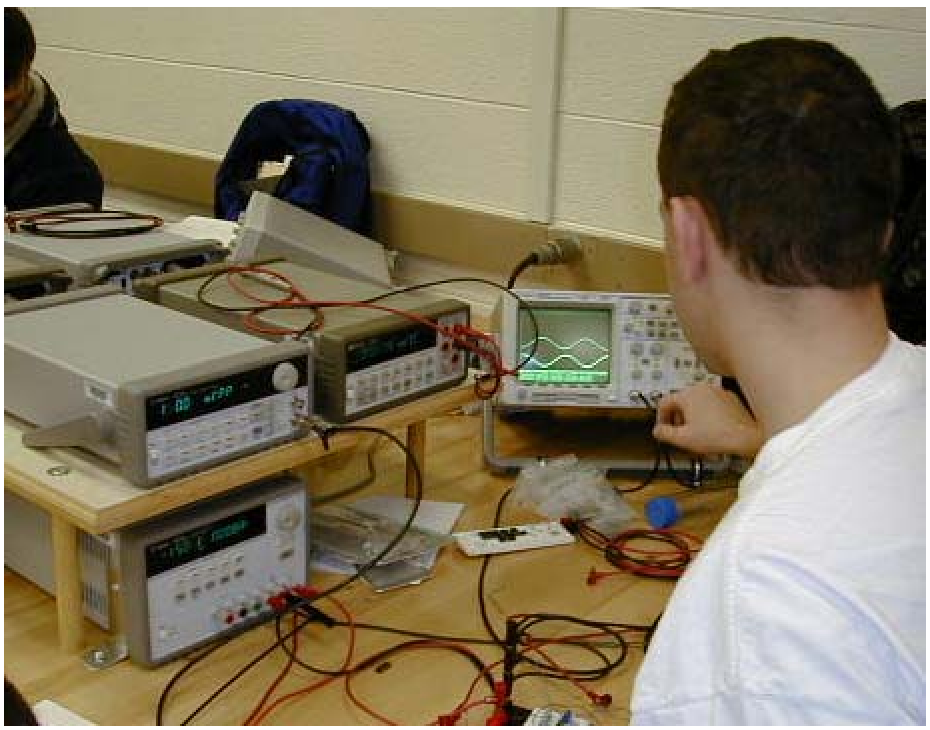

Figure 1. Lab station configuration

Experiment Qualities

The experiments performed have significant implications for non-students areas:

- Need for four identical labs. With the “rotation” technique, where the teams moved between professors every two weeks, four identical labs were required. MSOE has many labs, and at least four of them have the required identical, modern equipment. Each lab

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has 10-12 workstations, with each station having the Agilent® (or Hewlett-Packard®) items shown in Figure 1: Model 54622D Mixed Signal Oscilloscope, 33120A Arbitrary Waveform Generator, 34401A multimeter, and E3631A triple power supply. All instruments are GPIB (IEEE-488) interconnected, with special attachments for USB connection to the student laptop computers. Additionally, a PLC lab is required for one experiment. While less-expensive equipment could have been used to outfit the labs, it was believed that the freshmen should have the best available, to minimize the frustrations related to equipment idiosyncrasies.

- Need for all four professors to have the same times in their schedule allocated to this course. With complex faculty schedules involving committee assignments and other courses, this is not a trivial concern, especially at an institution where faculty members often teach three or more courses, sometimes with labs.

Several of the experiments use the students' laptop computers[6]. MSOE's "Technology Package" requires all incoming students to lease the same laptop computer from the university. This package includes software as well, insuring that students can be expected to apply this tool in any course. Thus, the course materials – schedules, syllabus, lab experiments, software packages, and sound files – were distributed on the Web (www.msoe.edu/eecs/ee/misc/100/).

The current package includes a Compaq® Armada® E-500 with 850 MHz Pentium® III processor, 20 GB hard disk, CD writer/DVD reader, 256 MB RAM, 15" display, modem and network interface. Many popular packages such as Microsoft® Office (and programming languages such as C++) and AutoCAD® are included along with the Windows® 2000 operating system. Students receive a completely new system every two years.

The use of the computer had several objectives – to show its use as a tool for EEs, demonstrate its benefit, get them familiar with the MSOE network, printers, etc., and have them be comfortable with the use of the computer in the lab.

Assessment

The students were surveyed before the course got underway, after each experiment, and at the end of the quarter. The intent of the first survey was to learn why they chose EE and MSOE. The most common answers to the "EE" question revolved around past experiences – either a summer course at a university (for high school students) or experiences in high school involving an electronics course. Another frequent answer cited the influence of a mentor (meaning that they liked the topics discussed or work performed, as opposed to choosing EE just to please an adult). Other less-common answers centered on the idea that they were "always interested in how electrical things worked."

The surveys taken after every experiment solicited written comments and a "vote" on how difficult the experiment was (see Figure 2). There were very few concerns about an experiment being "Very Difficult," perhaps due to the close interaction with the professors during the experiments. An interesting result is how easy the students thought the first experiment,

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Instrumentation, was. Perhaps it truly was simple, or perhaps they were enthused and unwilling to admit the slightest amount of defeat in their first week of college. Anecdotal evidence indicates it may have been both of the above.

The exit survey, in week 10, asked whether each experiment was interesting or not, on a scale from a high of "Very interesting" down to "Disliked experiment." Generally, the answers were above midscale. The written comments responding to "If you could change anything about the course, what would that be?" included "Nothing," "Course works for me," to "Add more design," "More experiments," etc.

The week 1 survey was anonymous, but the other surveys were identified by student name. There was no reluctance detected towards this process.

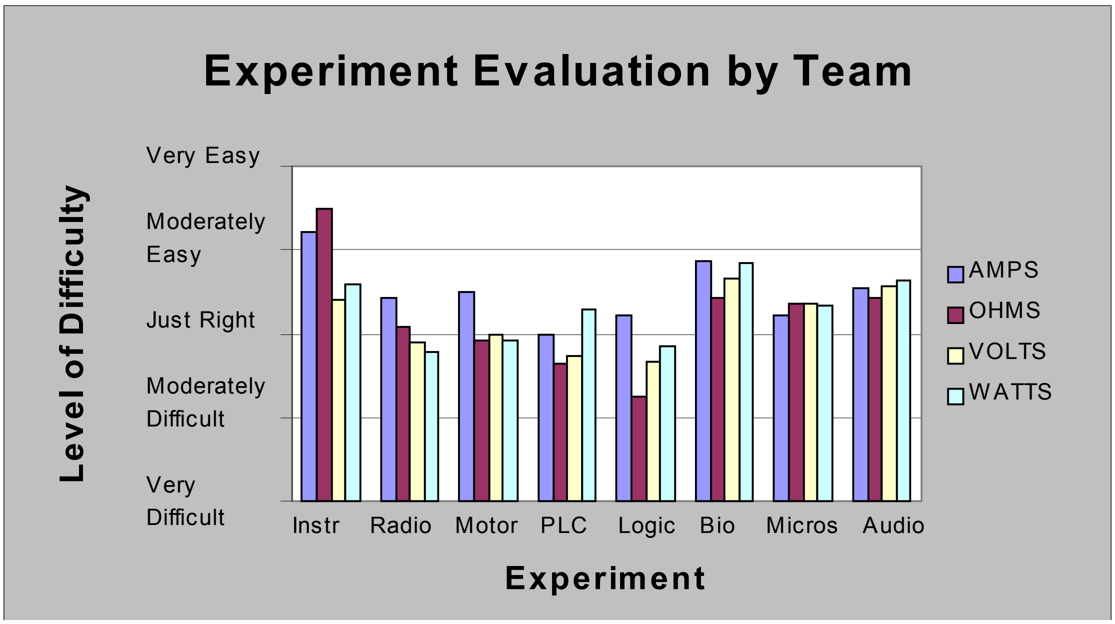

Figure 2. Student evaluation of experiment difficulty

Results

The results of the course on long-term retention remain to be determined. At the time of writing, one student had decided to switch from EE to ME, as a result of wanting a program with more "hands-on" involvement. The two students who failed are both still in the EE program. All of the rest, except for two students who left the university completely, are progressing.

It is hoped that the early contact with EE faculty and the topic areas will serve to keep them "connected" and enthused about their choice of careers. The faculty teaching the course all feel it was a rewarding and worthwhile experience.

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As to the course, changes for next time include a fresh look at the experiments to keep them current, and a reexamination of policies to make sure they are fair and complete.

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Biographies

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Dr. Steven Reyer is a Professor of electrical engineering at the Milwaukee School of Engineering, and has been on the faculty since 1984. His areas of interest are digital signal processing, communications, and microprocessor systems. He received his Ph.D. from Marquette University (candidate at University of Illinois) in 1978 after earning the MSEE and BSEE degrees at the University of Wisconsin – Milwaukee in 1973 and 1972.

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