Early Electrical Engineering Concepts Engagement
in a Freshman Level Introductory Course

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Abstract

This paper describes a new program recently introduced to the undergraduate electrical engineering curriculum at Lamar University that allows for early engagement of fundamentals in the freshman introductory course. The department initially instituted the Infinity Project curriculum developed by Southern Methodist University (SMU), but discovered that the program was skewed towards digital signal processing. Our new program complements and subsidizes the Infinity curriculum with laboratory exercises using the National Instruments ELVIS system that introduce the student to four fundamental areas of Electrical Engineering: logic, RLC networks, amplification and electromagnetics. The purpose of this course is to effect early engagement of students into the field to enhance both recruitment and retention. Results of student satisfaction surveys as well as faculty and lab assistant experience are reported.

Introduction

The State of Texas commissioned a statewide study for higher education, public colleges and universities titled *Closing the Gaps by 2015* (adopted in October 2000 by the Texas Higher Education Coordinating Board)[1]. The plan, which is directed at closing educational gaps within Texas, as well as between Texas and other states, has four goals: to close the gaps in student participation, student success, excellence, and research. The plan includes strategies for reaching each of the goals and an annual performance measuring system. One outcome of this plan was a demonstrated need for engineering education and an outcome of this was the creation of the non-profit membership organization known as the Texas Engineering and Technical Consortium (TETC). The purpose of TETC is to increase the number of engineering and computer science graduates from Texas institutions of higher education; and increase collaborative efforts between Texas universities, engineering and computer science departments, and private companies. A primary vehicle of this purpose is the awarding of grants for projects to strengthen instruction in

engineering and computer science and to institute recruitment, development, and retention programs for students in these programs.

In April of 2002 the Lamar University Department of Electrical Engineering was awarded a TETC grant titled *Launching the Texas Engineering Education Pipeline: Deploying The Infinity Project Statewide*. This grant enabled the department to join ten other universities (Baylor, Prairie View A&M, Rice, Southern Methodist, St. Mary's, Texas A&M, University of Texas at Arlington, Austin, El Paso and San Antonio) in a consortium to implement various aspects of the Infinity Project[2], a program developed to generate interest in K-12 and early college students in math and science-based engineering and technology. The project is an education initiative that helps educators deliver a maximum of engineering exposure with a minimum of training, expense and time. A key element of the Infinity Project is the use of Digital Signal Processing (DSP) hardware and a graphical software development system in a hands-on lab environment. The sophistication of the software allows high school and freshmen university level students a hands-on opportunity to perform engineering design and experimentation on high-tech topics including the Internet, wireless communications, digital imaging, and music and audio processing. At Lamar, we elected to implement the Infinity Project as a freshman introduction to electrical engineering course.

ELEN1200 Introduction to Electrical Engineering

The College of Engineering at Lamar University began offering four-year engineering programs in 1951. The programs have never been very large and Lamar prides itself on small student to faculty ratios and an emphasis on undergraduate teaching excellence in spite of the fact that it is a public institution with a robust engineering graduate program. One general aspect of many small engineering programs is the reliance on a central engineering core curriculum that all engineering students undergo. This strategy allows for efficiencies and guarantees minimum enrollments as well as consistent faculty workload across all departments in the college. Up until 2001, all engineering freshmen at Lamar were required to enroll in *ENGR1101 Introduction to Engineering*; a one-credit seminar type course intended to introduce the students to engineering in general and to survey the various engineering disciplines available in the college. After being awarded the TETC grant, Lamar Electrical Engineering was able to develop a separate course for pre-EE freshmen, *ELEN1200 Introduction to Electrical Engineering* based on the Infinity Project curriculum.

ELEN1200 is a two-credit lab/lecture course that meets twice weekly--a one-hour lecture session followed by a three-hour lab. The laboratory is critical to the course and involves a set of well-designed experiments intended to introduce the student to major aspects of electrical engineering study. One mechanism for this is the use of the Hyperception Visual Application Builder (VAB) software. The VAB uses a methodology of developing DSP algorithms and systems graphically by simply connecting functional components together with a mouse. A user only needs to choose the desired functions, place them onto a worksheet, select their parameters interactively, and describe their data flow using line connections. An illustration of this is shown in Figure 1. The Infinity Project lab experiments are all available on-line and include VAB worksheets that can be downloaded directly into the lab workstation. The DSP hardware is supplied by Texas

Instruments and real-time processing of speech signals is possible. The hardware also includes a digital camera for non-real-time image processing using the host PC.
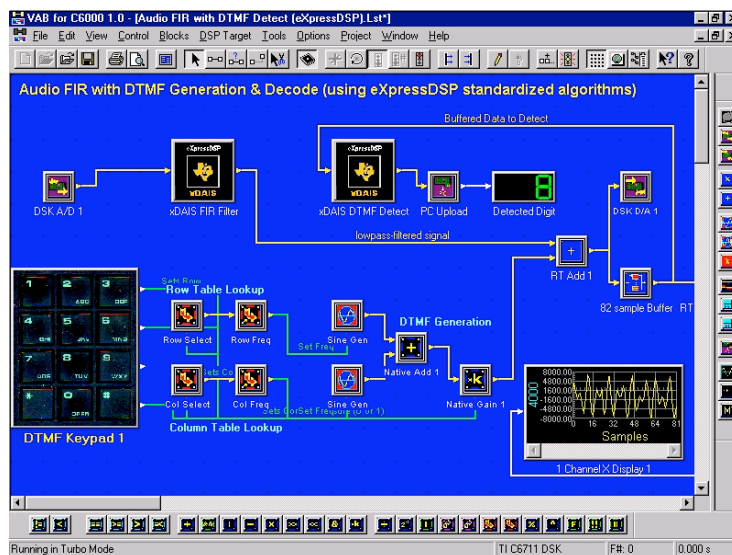

Figure 1. Visual Application Builder (VAB)

In the first year that we offered the program, we used the textbook[3] recommended for the Infinity Program and the online DSP-based lab experiments. We had originally been funded for fifteen lab stations, where each station includes a TI 6711 DSK (the DSP hardware), a Windows PC, speakers, microphone, CCD camera and VAB software. Our plan was to set-up a ten-station lab that would, in the limit, support twenty students with two students per station. We would hold five stations in reserve for spares and to allow the instructors and department chair to have a station in their office. There was deep concern that the course would not 'make' as the university minimum to run a course is ten students. The reason for the concern was twofold. First, our course was two credits while the college course was only one. Students taking our course would have to pay more and attend a three-hour lab in addition to the lecture. Secondly, a student who later decided to leave the EE program for a different engineering discipline would most likely have to take the college course anyway. Since it was an experimental course, we had to make it optional even for EE students. As a failsafe measure, the department required EE scholarship students to take the course guaranteeing an inaugural enrollment of at least seven. It turned out that our fears were ungrounded and we had thirty-six students sign-up for the course. We had to scramble at the last minute to put the five spare stations on-line and to order three more to bring the total to eighteen. We now have twenty stations and forty students is the maximum that the lab can handle.

Lessons Learned and Course Revision

Following our first year's success, the conclusion was that the Infinity Project curriculum, although an excellent program for generating interest in Electrical Engineering, was too narrowly focused on DSP projects. The second year it was decided to adopt a more general textbook for

the course. The instructor switched to *Electrical Engineering Uncovered*[4] by UC Berkeley Professors Richard White and Roger Doering. This book is very unique in that it uses water flow examples for analogies to current and voltage. It is important to understand that the students taking the course are college freshmen and may not have had calculus and physics. The department was also in the process of upgrading our circuits and electronics labs to use the National Instruments (NI) Educational Laboratory Virtual Instrumention Suite (ELVIS). NI had given ten of the systems to the department. An ELVIS station, see Figure 2, consists of five components: 1) a desktop computer running LabView software, 2) a DAQ device (digital/analog I/O) installed in the computer, 3) a connecting cable from the computer-DAQ to the ELVIS station, 4) a prototyping board that allows the student to access signals produced by the computer and to input those signals to an electronic circuit and then use the computer to analyze the signals, and 5) the ELVIS Benchtop Workstation that supports both the prototyping board and the LabView software.
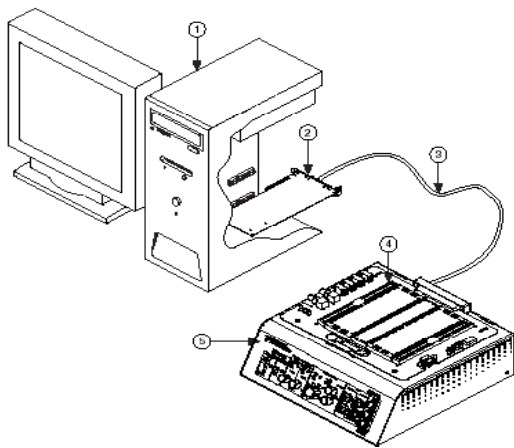
Most EE departments are familiar with LabView and its use, what the ELVIS does is bring the power of the LabView software directly into the hands of the student. With one relatively compact station the student has access to programmable power supplies, signal generators, DVM, oscilloscope, spectrum and multichannel analyzers and many other virtual instruments—see Figure 2. Knobs and switches on the front panel of the ELVIS interface to the virtual instrumentation to allow for an *analog feel*. The student can collect lab data, paste it into a spreadsheet or Matlab for analysis and then import the results to a word processing program for their report.

With access to the ELVIS system, it was decided to add labs to the introductory course that would encapsulate the four basic fundamentals of electrical engineering: digital logic, electromagnetics, RLC circuits and electronics (amplification).
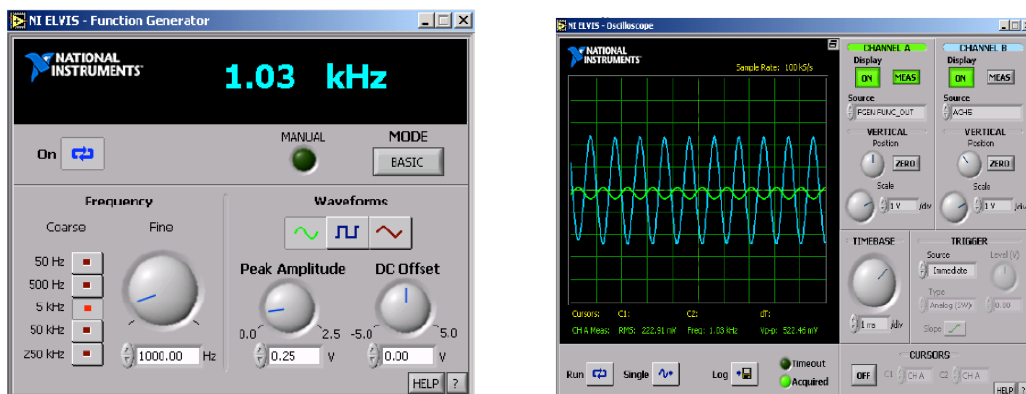

Figure 2. NI ELVIS/LabView Function Generator and Oscilloscope

The four fundamentals labs had to follow the same constraints as that of the other labs—be accessible to college freshmen. We also followed a similar format to that of the Infinity project in that the labs were put online at our department server. Figure 3 shows the wiring for the RLC circuit lab as configured in the solderless breadboard area of the ELVIS prototyping board. The narrow block at the bottom has solder tails that go into the PCB to allow DAQ signals to be easily accessed.
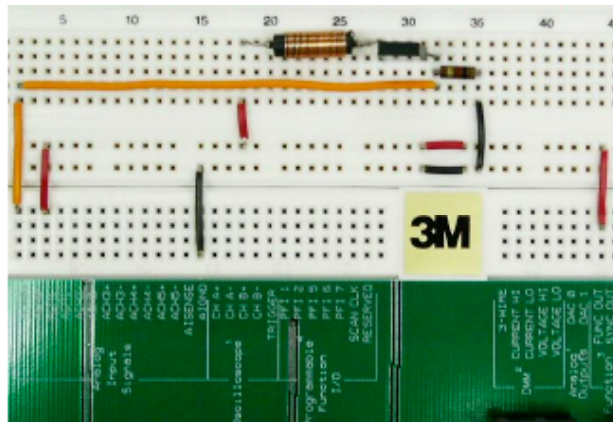

Figure 3. Component Layout for RLC Circuit Lab

Summary and Conclusions

This paper described the experience of the Lamar University Department of Electrical Engineering's experience with a new introductory course for freshmen. The purpose of the course was to effect early engagement of students into the field to enhance both recruitment and retention. We found that we met our purpose and were able to improve upon it. The first year that the course was offered we engaged thirty-six potential EE students and only two dropped out by the end of the semester. The second offering of the course a year later had an enrollment of forty students, which is the facilities limit for the course. We are now considering offering the course during both fall and spring semesters because in our case excess enrollment is a good problem to have.

One problem with EE retention is the fact that students do not encounter EE courses until the second semester of the sophomore year when they take Circuits I. The fall semester introduction course means that the department gets early engagement of our students that translates to easier following of them for advisement and support. We now have what we call the 'EE Winter' that is the spring and fall semesters following the introduction course and prior to the Circuits I course. During this time we encourage the students to be active in the IEEE student chapter activities and we schedule techno-social events like senior projects showcases to keep them in touch with the department.

Results of student satisfaction surveys have been positive for the course. The faculty and lab assistant experience has been enhanced with the adoption of the new text and the addition of the fundamentals labs. We have even had comments from juniors and seniors who wondered why we didn't have these labs available "when they went through." The use of the software systems coupled to hardware lends flexibility not possible with dedicated lab instrumentation and is more consistent with the directions being taken in industry. We are also able to seamlessly couple the lab experience to the development of technical writing, data analysis and presentation tools as well as immediate network access to resources such as manuals, data sheets, support sites and other materials. The labs described in this paper are available for download at http://ee.lamar.edu/EELABS.

References

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