Session 2148

Distance Learning Opportunities for Electronic Engineering Technology Graduates of Community Colleges

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ABSTRACT

A growing pool of graduates from the two-year community college technology programs has become aware of the need for expanded knowledge and the B.S. degree to enhance their professional opportunities. Unfortunately, many of these graduates are working and are isolated by distance from the limited number of universities that provide the B.S. degree in Technology and by the times they can attend classes. Distance learning provides a solution to this challenge, but creates the dilemma associated with teaching lab-intensive courses off campus. It is too expensive to buy equipment that is used irregularly; yet it is too cumbersome to haul the equipment back and forth. One solution to teaching electronic lab-intensive courses is National Instruments' NI ELVIS (Educational Laboratory Virtual Instrumentation Suite) which integrates both hardware and software to shrink the workspace to only two elements: the experiment interface and a computer. All the traditional instruments (DMM, function generator, oscilloscope, spectrum analyzer) are now software. In addition, specialized instruments such as a transistor curve tracer, programmable power supplies, vector impedance meter, arbitrary waveform analyzer, 8-bit digital bus drivers are included in the suite of software instruments. Both hardware and software are completely open so innovation at the experiment, interfacing, or software level can flourish.

INTRODUCTION

The Problem

The knowledge base and credentials required for job advancement in technology continue to increase. A growing pool of graduates from the two-year community college technology programs has become aware of the need for increased technical knowledge and the B.S. degree to enhance its professional opportunities and growth. Unfortunately, members of this pool are often older, have job and family obligations, and are isolated by significant distances from any four-year technology program.

The desire to obtain the knowledge and credentials for professional growth has been demonstrated at East Tennessee State University by the successful cohort programs developed by the Industrial Technology Program and the Construction Engineering Technology Program in

Knoxville, Tennessee. These cohort programs consist of a group of two-year community college graduates that take the same courses until they complete the requirements for graduation at East Tennessee State University. Presently, the Industrial Technology Program has 50 students in its cohort program, and the Construction Engineering Technology Program has 35 students.

The Electronic Engineering Technology Program at East Tennessee State University has watched with envy while these cohort programs have flourished, realizing the dilemma of teaching a laboratory equipment intensive curriculum using the cohort system, especially off site. Required laboratory equipment is too expensive to be used irregularly and too cumbersome to haul the back and forth to offsite locations.

The Solution

ELVIS has left the building! National Instruments has pioneered a new educational suite, NI ELVIS (Educational Laboratory Virtual Instrumentation Suite), Figure 1, which integrates both hardware and software to shrink the electronics lab to only two elements; the experiment

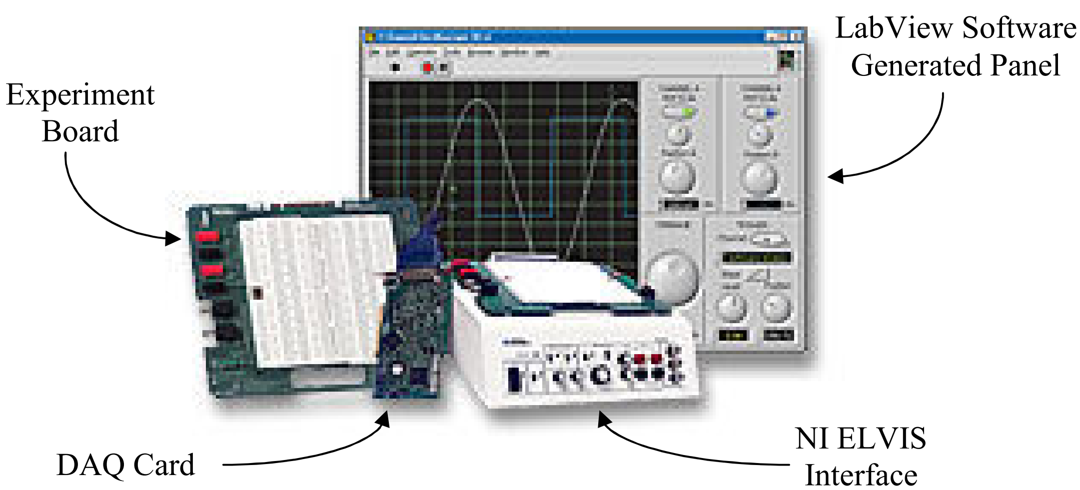

Figure 1. NI System

interface and a computer. All the traditional instruments (DMM, function generator, oscilloscope, spectrum analyzer) are now software. In addition, specialized instruments such as a transistor curve tracer, programmable power supplies, vector impedance meter, arbitrary waveform analyzer, 8-bit digital bus drivers are included in the suite of software instruments.

Cost for NI ELVIS is $2400 in quantity, about the cost of a personal computer. NI ELVIS includes the data acquisition (DAQ) card that goes into the computer, the NI ELVIS interface box that includes fuses and the interface, the experiment board, and the power supply. Like the IBM PC of the early 80's, both hardware and software are completely open so innovation at the experiment, interfacing or software level can flourish. The students can use the software instruments or embed them into a LabVIEW program for complete computer automation or even write their own measurement and control algorithms. The experiment board cost about $100 and is removable, allowing students to do the circuit wiring at home.

THE STUDY

The Study

The feasibility study we are attempting at East Tennessee State University (ETSU) consists of using NI ELVIS and obtaining or developing applications that parallel several of the advanced (ENTC 3XXX/4XXX) courses of the Electronic Engineering Technology Program at ETSU, seeking an evaluation of the feasibility of offering the advanced electronic courses at off-site locations, and distributing our results through engineering technology conferences and publications. To this end, we have purchased three NI ELVIS systems and are in the process of developing the labs during the Spring 2004 semester.

NI ELVIS was chosen foremost for its versatility, but NI ELVIS was also chosen based on the LabVIEW software which provides remote control capabilities[1]. Thus LabVIEW provides the ability to develop a remote laboratory consisting of a remote laboratory server that can be an experiment connected to a computer through a standard interface and with the host computer connected to the Internet. The client can be any computer connected to the Internet running a simple browser. Once connected, the client will see the same front panel as the local host and also have the same program functionality, Figure 2.

The user simply points the Web browser to the Web page associated with the application. When the user interface for the application shows up in the Web browser, then the application is fully accessible by the remote user. The acquisition occurs on the host computer, but the remote user has total control and identical application functionality. Other users can also point their Web browser to the same URL to monitor the application in progress. Only one client can control the

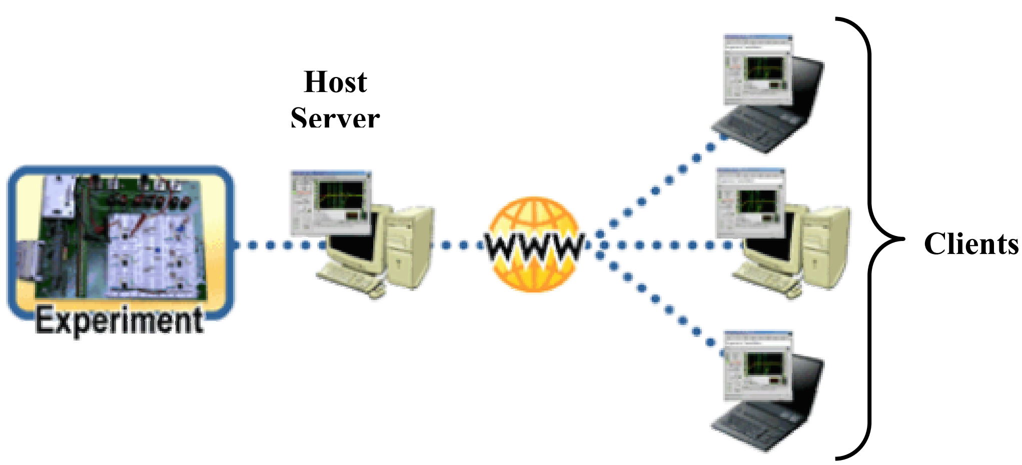

Figure 2. Remote control using LabVIEW

application at a time, but the client can pass control easily among the various clients at run-time. At any time during this process, the operator of the host machine can assume control of the application back from the client currently in control.

This remote capability provides several nice options for the administration of the laboratory. First, the instructor will have physical access to the student's lab, allowing the instructor to troubleshoot lab problems as well as evaluate the completed lab. Secondly, the instructor can create a demonstration using more expensive, less available specialized equipment and allow the remote students to control and monitor the demonstration variables. Likewise, the instructor has the option of developing a lab practical for the lab section of the course. The lab practical could be performed remotely or at the instructor's institution, depending upon the instructor's preferences.

Assessment of the Study

Distance learning is becoming a standard offering by most colleges. There are two major challenges in distance learning, especially when the laboratory is involved. One challenge is to develop distance learning that meets the quality indicators of the students[2]: expectations are clearly stated; feedback is clear, timely, and meaningful; connection with the professor (effective instructor-to-student and student-to-instructor) communication; anytime, anyplace learning; and incorporation of leading-edge technologies. The other challenge is to meet the course content driven quality indicators[3]: quality of work and timeliness of work.

Cohen and Ellis[2] suggest that online learners want prompt and specific feedback; otherwise they tend to feel isolated. This isolation is intensified by the fact that the student and instructor do not have the *normal* clock to measure the passage of time through the course. Connection with the professor was deemed important for facilitating learning. Incorporation of leading-edge technology is a reasonable expectation of quality for technologically oriented students. Mbarika *et al* [3] define the indicator of *quality* as the right data at the right level of detail and the indicator of *timeliness* as the students' ability to complete the task on time.

Two assessment instruments will use these constructs to measure the success of the study. One assessment instrument will be completed by the student using a scale ranging from -2 for "Disastrous to a good online course" to 2 for "Crucial to a good online course". The categories of student related quality indicators are listed in Table 1. The second assessment instrument will be completed by the instructor using a scale ranging from 1 for "The student was there" to 7 "Even the instructor could not have done better". The categories of course-content related quality indicators are listed in Table 2.

Concurrent Studies

NI ELVIS was invented by physics professors Paul Dixon and Tim Usher in collaboration with National Instruments[4]. The two professors and NI are working closely to promote the development of educational curricula to bring the new technology to undergraduate and graduate institutions. This effort has been endorsed and will be supported by a grant of approximately half-million dollars from the National Science Foundation to develop a wide range of instructional materials for students and curricular development tools for instructors. Future applications are under development for other science disciplines, as well as for distance education for students unable to attend traditional classes.

Table 1	Table 2
Student Quality Indicators in an Online Course	**Course-Content Quality Indicators in an Online Course**
Connection with the professor	Timeliness
Connection with other students	Learning
Student-centered	Quality
Expectations clearly articulated	Teamwork
Effective instructor-to-student communication	Oral and written communications
Effective student-to-instructor communication	Incorporation of leading edge technologies
Effective student-to-student communication	
Anytime, anyplace learning	
Self-paced schedule	
Simulates an in class "feel"	
Class size	
Feedback clear, timely, and meaningful	
Adequately prepared for online course	
Incorporation of leading edge technologies	
Self reported learning	
Challenging learning	

The Genesis Project, a Texas Engineering and Technical Consortium (TETC) and National Instruments Initiative, brings together electrical engineering programs from throughout Texas to discuss and implement new ways to engage students early and throughout their electrical engineering experience with relevant, hands on laboratories and design projects[5]. The project grants 10 NI ELVIS systems to each TETC eligible electrical engineering program.

The Intellectual Merit of the Study

The TAC-ABET accredited Electronic Engineering Technology program at ETSU is well suited for a study on distance learning opportunities in electronic engineering technology for regionally isolated graduates of two-year electronic engineering technology programs. The majority of students entering the Electronic Engineering Technology program are transfer students from two-year electronic engineering technology programs. Therefore, the courses used in the study provide a representative population. In addition, East Tennessee State University is the only four-year engineering technology program in a generally vast, rural, and mountainous region where distances and terrain provide obstacles to access.

The intellectual merit of the study involves the examination of an ongoing dilemma in general education. How do you provide quality, affordable education to anyone at any time at any location? This fundamental question in general education is exacerbated in technical education because of the lab-intensive nature of technology. NI ELVIS provides a potential solution to the lab-intensive segment of technical education.

The Broader Impact of the Study

The results of the study should be transferable. Like many states, Tennessee has numerous community colleges with significantly fewer regional universities located throughout the State. Thus, the population has the easiest access to the community colleges and their two-year programs. With fewer regional universities, the access becomes more difficult due to distances and obligations. University access and access to more advanced technical knowledge becomes almost impossible when high cost, highly specialized equipment is needed for the lab experiences in the course.

The ability to expand electronic engineering technology programs to isolated regions is especially important in Tennessee and Central Appalachia. The rugged Appalachian Mountains have provided the borders for one of America's severest underclass societies[6]. The stereotype of the backward hillbilly, the uneducated mountaineer, and the rebellious coal miner has produced *de facto* discrimination by other regions toward the area. As a result, the region has never developed the skilled labor to compete technologically. The region has only had a comparative advantage in industries that intensively use natural resources and unskilled labor, promoting a concentration in traditionally low-wage industries. Unfortunately, these low-wage industries are the most likely to transfer to countries where wages are even lower.

SUMMARY

Berry *et al* [7] believe that the next decade will provide unlimited opportunities for developing new and improved methods for delivering curriculum content. Specifically, they believe that educational institutions will place increased emphasis on improving the following methods:

- those that motivate students to learn on their own and retain knowledge;
- those that provide a deeper understanding of fundamental principles by developing methods for observing and/or experiencing them in action;
- those that reduce (but not eliminate) the amount of direct faculty; involvement in delivering course content, while improving the quality of direct interaction with students;
- those that allow anytime, anywhere delivery;
- those that provide the ability to educate limitless classes while promoting an atmosphere of small class size or, better still, a "personal educator."

Malki and Matarrita[8] believe that industry requirements for lifelong learning require educational institutions to develop learning environments to meet the need of non-traditional students. As a result, many courses taught traditionally in a lecture format now have a corresponding distance education offering. However, they report that laboratory experiments delivered asynchronously and at a distance are much more difficult to construct.

These two reports[7,8] summarize the purposes of the study. The objective is to develop a curriculum delivery strategy that is cost effective, flexible, and feasible and that allows kinesthetically (hands-on) and visually oriented engineering technology students access to labs that support technological concepts, theories, and ideas.

NI ELVIS provides one cost effective, flexible, and feasible opportunity to expand distance learning to the lab-intensive electronic engineering technology courses and expand opportunities for those technology graduates of locally available community colleges that are hindered from attending the engineering technology at the university. If the lab-intensive distance learning electronic engineering courses using NI ELVIS can satisfy the listed student and course-content quality factors, isolated regions and isolated populations will be opened to the same opportunities that large urban areas have. This will provide tremendous opportunities for the growing pool of two-year community college electronic technology graduates that is geographically or obligatorily isolated from a four-year technology program.

The access to the four-year technology degree for any two-year community college electronic graduate should encourage growth in both the two-year and four-year electronic engineering technology programs. This growth will provide more technologically literate employees for the ever-expanding technology needs in a region that is losing semi-skilled manufacturing jobs to foreign markets. The broader implication of the study is the potential for delivering laboratory-intensive electronic courses anywhere at any time to anyone.

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