Engineering Technology on the North Carolina Information Highway

**William Shelnutt, Ambrose Barry, Nan Byars, Jack Carter,
Cheng Liu, Connie Martin, Tom Owen, and Patricia Tolley
The University of North Carolina at Charlotte**

ABSTRACT

In the fall of 1997 we began offering a pilot program (funded by a grant from the University of North Carolina General Administration) of the BSET in Electrical Engineering Technology on the North Carolina Information Highway (NCIH) to three North Carolina Community College sites. Originating in an NCIH classroom on the UNC Charlotte campus, the classes are offered to sites at Forsyth Technical Community College in Winston Salem, Gaston College in Gastonia, and Wake Technical Community College in Raleigh. The NCIH affords two-way, live video and audio of the UNC Charlotte classes. The entire upper-division Electrical Engineering Technology program, with limited electives, will be offered over four years, including selected courses that will fulfill five of the six UNC Charlotte Goals of General Education. (Remaining Goal courses can be fulfilled at the community and technical colleges. Admission requires an AAS degree with a grade point average of at least 2.20 and certain prerequisite courses.) The program will typically use a two-days-per-week format for each of two courses per semester. In addition to TV classes, the program depends on Web-based assignments, email communications with the instructor, and library and computer materials at each site. Laboratory courses will be taught as concentrated four-Saturdays-on-campus sessions of three experiments per day for each of four courses. We have appointed a half-time site coordinator for each site to take care of logistics such as registration, books, handouts, proctoring tests, and, in two of the three cases, operating the cameras. We have attempted to set up a distance-learning Mentoring Program with on-site mentors for these students in a model similar to the quite-successful one initiated in the last two years on the UNC Charlotte campus, but we had difficulty locating suitable mentors. On-site supplementary instructors were employed beginning in the second semester (spring 1998).

Although we could not begin advertising the program until well into the summer we overfilled two of the three sites with qualified students, requiring us to quickly find an alternate NCIH classroom at one site and additional seats at another. A total of 72 students were registered for this pilot cohort. Each of the host community colleges offered a calculus remedial/refresher course on a complementary night this first semester. The student population we have recruited is clearly non-traditional (with a median time since earning the AAS degree of five years), with families and jobs which preclude their coming to Charlotte to attend the BSET program on campus. They seem profoundly grateful for this opportunity. The popularity of this pilot program argues for its continuation with additional cohorts, and we have received requests for a similar offering of Mechanical Engineering Technology. However, we must address several issues related to funding, limited seating capacity at NCIH sites, limited availability of

broadcast hours, significant student attrition, and demands on faculty time before we extend and broaden the program.

Introduction

A grant from the General Administration of the University of North Carolina has funded a pilot distance education program in Electrical Engineering Technology at the University of North Carolina at Charlotte, beginning in the Fall of 1997. Our goal was to offer insofar as possible the same program as is offered to on-campus students. In many important respects it *is* the same program, since the classes are live television broadcasts of on-campus classes. However, duplicating other services such as registration, advising, mentoring, laboratories, computer access, and library access is not straightforward. This paper describes the program, the three distant sites, class format and operation, advising, recruiting and admissions, early attrition, the summer on-campus laboratory format, mentoring and tutoring, program evaluation, and issues and plans.

The Electrical Engineering Technology (ELET) Distance Program

This is an upper-division-only Bachelor of Science Degree (BSET) program requiring an Associate in Applied Science (AAS) degree for admission. Each admitted student receives 64 semester-hours credit for the associate degree and completes an additional 60 hours to meet requirements for the BSET degree. With the exception of one science course, one humanities/social science elective, and four laboratory courses (offered on Saturdays during the summers), all courses in these 60 hours are offered on the North Carolina Information Highway (NCIH), which affords live, two-way, video and audio presentations from the UNC Charlotte Campus to three chosen sites in North Carolina. Six semester hours, representing the science course and the humanities/social science elective course, may be taken at the cooperating technical and community colleges, for a total of 70 semester hours of such transfer credit (for students in this distance learning program only).

Even though the program is spaced out over a period of four or more years, it is a relatively intensive commitment for the working adults, many with families, which it serves. It requires taking two courses per semester, involving two evenings per week plus study and research time. And it is relentless, maintaining this pace for four years. Furthermore, since there are no other cohorts planned at this time, any failure or withdrawal from a required course is tantamount to dropping out of the program.

Relationships with Technical and Community Colleges

UNC Charlotte has historically had close and effective relationships with the Technical and Community Colleges in North Carolina, since our upper-division-only programs depend on these colleges for transfer students to populate our classes. The three colleges participating in this program were among the most productive in terms of student transfers to our programs. Each had a potential pool of AAS program degree graduates who might be interested in continuing for the BSET degree if it were compatible with work and family demands on their

time. Early in the planning for this distance learning program we held meetings with each of the Chief Academic Officers and their staffs at each of the colleges to discuss what the program would entail and how we might cooperate. With the enthusiastic cooperation of each college, we proceeded with our plans.

The Three Distant Sites

In this pilot offering we are cooperating with three North Carolina Community Colleges: Forsyth Technical Community College (TCC), Gaston College, and Wake TCC. Forsyth TCC, located in Winston Salem, approximately 60 miles northeast of Charlotte, hosts the distance learning sessions in the NCIH classroom on their campus. Gaston College, located in Gastonia, approximately 25 miles west of Charlotte, also hosts the distance learning sessions in their campus NCIH classroom. The classes associated with Wake TCC, approximately 150 miles northeast of Charlotte, are held in the SIPS (State Information Processing Services) NCIH site in downtown Raleigh, since Wake TCC does not currently have an NCIH site. Each of the three sites have large video monitors in front of the classroom, automatic-on microphones at each student desk position, and one or more video cameras to return views of the students in the classes.

Class Format and Operation

NCIH Classroom A live class section at UNC Charlotte is broadcast from an NCIH televideo classroom with seating for approximately 75 students. The classroom is equipped with two large monitors and a video projector that show the outgoing video images. Microphones at each pair of students' desk stations automatically switch on as students ask questions, and a rear-facing aimable, zoom camera provides a view of the students. Typically the instructor's notes or vu-graphs are shot with a vertical overhead camera on a 5-inch by 7-inch working area on an adjustable, castered, horizontal podium set at approximately 48 inches from the floor. Twin, aimable, zoom cameras mounted on a platform approximately 9 feet high and 30 feet from the podium provide views of the instructor and a greenboard behind the podium. The platform also includes a large (30-inch) monitor with a quartered screen showing the outgoing feed and the return from each of the three sites. Cables to take monitor output from laptop computers are wired up to the podium, and 9-inch monitors (to show laptop output and the overhead camera output) face the instructor just below desk level in front of the first row of desks. This setup seems to work well with the exceptions that the high-set cameras make consistent instructor eye-contact with both the on-campus students and distance students difficult, and the site monitors are not large enough or close enough for the instructor to make out students' faces at the remote sites. Also, typical computer displays have unsatisfactory resolution on the television screens unless very large fonts are displayed.

Appropriate Technology Live television broadcast of on-campus classes has attractive features such as continuation of a format familiar to faculty and relatively low preparation time requirements (compared to web-based courses). The availability of the NCIH in North Carolina argues for it. However, a strong case can be made that dependence on videoconferencing for remote-group teaching has a high opportunity cost: it does not respond to what has been termed ". . . crises in access, cost, and flexibility" in American higher education (Daniel, 1997). In the

next year or so we intend to explore alternatives now afforded by world-wide-web technology which do address these crises. Indeed, examples of this new technology's success may be seen in the largest eleven "mega-universities" in the world, with distance learning enrollments ranging from 110,000 to 530,000 students (1995 figures; Daniel, 1997), none of which are in the United States.

Operation Typically, students will take two three-credit courses per semester, in two 80-minute classes on Monday and Wednesday evenings from 7 until 9:45 PM. In the first semester, fall 1997, the classes for ELET 3133 (Analysis of Linear Networks I) were offered on Monday evening only, in order to provide maximum flexibility for students to schedule the remedial calculus course at the local college if necessary. In the Spring of 1998, ELET 3124 (Analysis of Linear Networks II) is a four-credit course requiring two hours each evening. The format for each class typically involves a lecture, problem solving demonstration, and questions from students at any site. Use of the program PSPICE is an integral part of the curriculum, and computers with this software installed are available at each college site. Other software may be added as needed.

Initially we thought it likely that each student would have access to the Internet, either at home or in the work environment, but we found that not to be universally the case. Computers with Internet access are provided at each community college site. However, since some of the colleges are not open on weekends, student access is less than optimal. Much of the course material is on the home page for the course ELET 3133, and the instructor depends on student access to it and email for questions of the instructor. Instructors may choose to keep "telephone office hours" in which a student may call with questions, and instructors may choose to take telephone calls at their homes. We have also set up a chat room for questions in common and student comments, as well as a bulletin board for asynchronous questions and answers.

Site Program Coordinators A half-time program coordinator at each site is responsible for handling all logistics, including registration, attendance, test monitoring, and distribution of handout material. At two of the sites, the coordinators also serve as technician and camera operator. Clearly, however, the coordinators' most important job has become that of communication conduit between the students and the instructors and administrators of the program. These program coordinators were hired specifically for these positions in the summer before the program started. The UNC Charlotte Director of the Office of Continuing Education and Extension serves as supervisor of the site coordinators. That office also is responsible for negotiations with community college sites (including providing equipment to the sites and arranging for its use), negotiating library arrangements, computer access, payment for use of facilities, etc.

Courier A courier dedicated to the program drives to each site for delivery and pickup of materials once per week. This is supplemented by FAX transmissions for copying at each site, or by one-day special delivery (FED-EX or UPS) for critical items in emergencies.

Administration

Program administration is accomplished by the cadre of Engineering Technology instructors designated to teach the courses (currently five instructors), an Academic Program Coordinator, and an overall program Distance Learning Coordinator, currently the Director of the Office of Continuing Education and Extension. This latter office is responsible for overall logistics for the program, and in particular for those activities not currently supported in a distance learning format, including registration, student payments and accounts, distribution of drop/add, and hiring and payment of site coordinators. The Department of Engineering Technology and its Chair are responsible for all academic matters, including admissions (in cooperation with Office of Admissions), instruction, testing, grading and grade reporting, advising, and graduation checklists.

Weekly meetings of the instructors, the academic program coordinator, the Department Chairperson, and the Assistant Chairperson focus on opportunities to improve the program based on feedback from the students and the site coordinators. Periodic on-campus meetings of all site coordinators with the Distance Learning Coordinator and the Academic Program coordinator provide an opportunity to discuss long-term issues and opportunities for improvement.

Advising

One instructor, who also serves as Assistant to the Chair of the Department, advises all the students at all sites. During the admissions process, each student was notified of any deficiencies (missing courses) in his or her AAS program that must be made up, but choices of particular humanities electives and transfer credit for any work beyond the AAS degree require careful advising to avoid lengthening the student's program. We envision that advising will take place by telephone, email, and FAX as the program continues, and will accelerate when each student's transcript(s) is evaluated for specific types of general education credit.

Laboratory Format

Laboratory courses are offered on the UNC Charlotte campus on four alternating Saturdays during each summer (from late May to early July). Each student completes three laboratory experiments on a Saturday, then writes them up for submission two weeks later. The last laboratory session, for ELET Laboratory IV, may be offered as a new course, ELET 3641 Senior Design Project, in the last year of the program. We anticipate requiring at least two faculty members and one teaching assistant on each Saturday. Two sections will be offered simultaneously on the UNC Charlotte campus on four Saturdays.

With the cooperation of Wake Technical College, two similar special sections of laboratory sessions are being planned for the students at the Raleigh site to preclude their having to make the 3-hour drive to Charlotte. A UNC Charlotte Engineering Technology instructor will drive to the Wake Technical College site on the designated Saturdays and use laboratory equipment there, bringing any specialized equipment and expendable supplies needed. These two sections will be offered as morning/afternoon and as afternoon/evening options on six

Saturdays. These laboratories will essentially duplicate the laboratory sessions on the UNC Charlotte campus.

Recruiting and Admissions

To recruit students we advertised in the local newspapers in the city of each site, notified employers in each area, and enlisted the help of the participating Community College. Each student making an inquiry was sent a package containing a descriptive brochure and a specially marked admissions application form identifying it as an application to the Distance Learning Program. These forms were evaluated separately from on-campus admissions and sent directly to the distance learning academic coordinator for final determination of eligibility. Differences from the on-campus admissions included the proviso that no more than two course deficiencies in the AAS degree program were allowed, and these deficiencies must be remediable at the community college site without delaying progression in the program. Other admission requirements, including certain stipulated courses in the AAS degree program and a minimum 2.20 grade point average, were the same as for on-campus students.

Although the timing of the grant approval from the University General Administration did not allow us to begin recruiting until June of 1997, we received 80 applications, of which 76 were qualified for admission to the program. Between our cut-off date of July 21 and the start of classes on August 20, all fully-qualified applicants were admitted immediately if space was available at the site desired. To accommodate a greater than expected number of applicants, we opened a second classroom at the Forsyth TCC site, and we moved the Wake TCC site to a larger NCIH classroom (SIPS). For this first semester we enrolled 29 students at Forsyth TCC, 18 students at Gaston College, and 25 students at Wake TCC, for a total beginning class of 72 students. Initial enrollments, however, were subject to early attrition, as discussed below.

Characteristics of Enrollees

Virtually all of the students enrolled in this program are full-time employees working near the site of their enrollment. The median length of time since earning the AAS degree was five years, ranging from zero to 22 years. Of the original 72 enrollees, four were female. Many have families and other responsibilities that prevented them from moving to UNC Charlotte to obtain their BSET degrees. (The only other BSET program in ELET in North Carolina is at Western Carolina University in the westernmost portion of the state.) The median GPA of enrollees in their AAS degree programs was 3.09, ranging from 2.23 to 4.0. Many of these students expressed profuse gratitude at being afforded an opportunity to complete their baccalaureate degree in a part-time program offered in the evening near their work and home.

Attrition

Early attrition within the first month of classes reduced the enrollment to a total of 66 students (26 at Forsyth TCC, 15 at Gaston College, and 25 at Wake TCC). By the middle of November the total had fallen by 25% to 54 students (19 at Forsyth TCC, 10 at Gaston College, and 25 at Wake TCC). An analysis of the reasons given by students for withdrawing from the program (by mid semester, Fall 1997) is shown in Table 1. Forty six students returned

to begin the Spring 1998 semester (12 at Forsyth TCC, 10 at Gaston College, and 24 at Wake TCC).

Table 1 Reasons Given by Students for Early Withdrawal from Program
(at Mid-semester Fall, 1997. Total exceeds the18 drops from the program due to multiple reasons given).

Reason Given	Number of Students	Comments
Increased work commitments or promotion	7	Several also said didn't enjoy program
Increased work travel	2	
Too much time away from family	2	One mentioned community activities
Curriculum different from expectations	1	
Did not enjoy classes or course presentation	3	
Decided to pursue another program	1	Plans to pursue a part time BS program in computers which can be completed in 2 yrs
Personal reasons	3	One student got married
Took too much time	1	
Coursework too difficult (or not prepared for it)	2	

Mentoring

In an effort to minimize attrition and provide students with the same services offered on campus, the College of Engineering Mentoring Program attempted to find peer mentors for each site. Peer mentors are carefully selected and specially trained to teach and help implement academic success strategies such as time management, study skills and test-taking strategies. This approach, however, was met with limited success.

Because of its close proximity to the campus, a very qualified peer mentor was hired to work with the students at Gaston College in Fall 1997. The mentor was contracted for five hours per week and also paid mileage. This arrangement was very successful because the student had previously made an A in the course and, therefore, was very comfortable with the course material. His interpersonal and communication skills were instrumental in helping identify and communicate to the instructor and site coordinator the specific needs of the students. It was also evident that offering this service on site, as compared to over NCIH, for example, was important because the mentor was able to provide immediate, relevant and one-on-one feedback to students as necessary.

Due to a number of factors, including identifying mentors, scheduling, logistics, and availability of appropriate facilities, we failed to secure mentors at the other two sites in these first two semesters. Finding a peer mentor in the Raleigh area was found to be virtually impossible. Potential mentors were solicited from graduate students in the Electrical Engineering program at North Carolina State University, local professionals and retirees, UNC

Charlotte alumni working in the area, and even former instructors from Wake TCC. However, a peer mentor was never identified.

Several important lessons were learned as a result of this effort to provide mentoring services:

(1) Students appear to enjoy and need the kind of in-person support offered at Gaston College.
(2) Students need a combination of mentoring and supplemental instruction/tutoring with the primary emphasis placed on the latter rather than the former.
(3) Asynchronous learning tools such as web based bulletin boards for posting questions and answers are needed to support classroom instruction and tutoring.

Based on these lessons learned, alternative approaches are being evaluated for implementation later in the program

Supplementary Instruction (SI)

In the second semester of the program (Spring 1998) we were successful in hiring supplementary instructors for the students at each site (three instructors total). These degreed engineers worked approximately ten hours per week for each of the two courses offered during that semester (a second course in electronic circuits and a course in applications of calculus), including attending the classes, preparing the homework assignments, and supplementary instruction with the students at prearranged times. Each SI instructor attended a one-day orientation and training session at UNC Charlotte before commencing work. At this writing we have not completed an evaluation of the effectiveness of this supplementary instruction, but it appears to be working well based on informal student comments.

Program Evaluation

We are tracking distance education aspects of the program each semester with a special questionnaire that elicits information on the relative success of program components. These include presentation quality; instructional materials quality; video and audio quality; instructor access by email, telephone, and internet; mentoring/tutoring; program administration; the site coordinator's role; and access to support services such as registration, admissions, and records. In addition, we administer the standard end-of -semester evaluation of courses by students that on-campus students fill out each semester for each course. As of this writing, evaluations for the first semester have been obtained, but analysis is not yet complete. A mid-semester evaluation is planned for the two courses in the Spring 1998 semester.

Issues and Plans

During the recruiting process we found that many more AAS graduates in North Carolina would be interested in entering the ELET program if we expanded it to start additional cohorts of students in succeeding years. A significant demand was evidenced for offering the Mechanical

Engineering Technology program as well. However, we must address several issues before commencing additional cohorts or expanding the program to other technologies:

- *Financial viability of the program after pilot funding support ceases:*
    - At this point we do not have reliable figures on the costs of offering and supporting this evolving program. Based on this experience we intend to create a realistic budget for any further cohorts, possibly beginning in Fall 1999.
- *Gaining state subsidy for distance learning students (state appropriations provided for distance learning students in a formula similar to that used to fund on-campus instruction):*
    - Indications from the University of North Carolina (system) General Administration are that distance learning offerings beginning in the Fall 1998 semester and thereafter will be offered at standard tuition rates, with additional fees to be determined (in lieu of the standard on-campus fees). Campuses will be funded for the delivery of these courses and programs using a formula similar to that used to fund on-campus instruction, but tuition/appropriations supporting distance learning/extension activities will be tracked and monitored separately from on-campus instruction.
- *The limited availability of evening broadcast hours on the NCIH television system:*
    - We are exploring alternative delivery mechanisms, including ISDN (Integrated Services Digital Network) telephone lines for video and audio transmission to and from each of the sites. Initially this will likely be for mentoring or supplementary instruction only, but the ISDN delivery mode could be extended to delivery of classroom instructions as well. The NCIH network itself will likely migrate to another technology, perhaps ISDN. Further in the future it is likely that internet capabilities (primarily bandwidth limited) will be extended to be capable of handling live video and audio transmissions. Both of these delivery mechanisms do not suffer the same broadcast-hours-availability limitations as the NCIH, but the internet capabilities as yet provide decidedly inferior video and audio.
- *The limited seating capacities (on the order of 20-25) of current NCIH classrooms:*
    - With the alternative delivery mechanisms mentioned above, the limitation is only that of a classroom with ISDN (or internet) lines, computer systems, monitors, microphones, and speakers. These facilities will be more portable and less expensive than the NCIH facilities required. Of course, the participating technical/community colleges must be receptive to installation and use of these technologies on their campuses.
- *The increased demand on faculty time for development and operation of distance learning courses, which we estimate conservatively to be at least twice that of on-campus lecture courses of similar enrollment:*
    - We are struggling, along with other universities, with development of strategies for defining equitable work loads for faculty involved in distance learning courses. A confounding factor is the diversity of distance learning modes utilized — clearly a TV broadcast of a course typically offered on campus requires more preparation and effort that the same course in a standard classroom format, but much less effort than developing an

asynchronous version of the course for the internet. Parity for faculty workload with respect to the number of students served via distance learning compared to on-campus numbers must be addressed. Demands on faculty for advising and telephone/internet/email/FAX office hours are dependent on setting, delivery mode, and any other available assistance. We expect our pilot efforts to shed some light on these questions, but their resolution will await replication of efforts in a variety of delivery modes.

- *Providing effective support services to distant students, particularly peer mentoring and tutoring:*
    - Our only-partially-activated peer mentoring efforts and experience with paid supplementary instructors at each site will provide us with some insight as to the effectiveness and cost implications of these services.
- *The limitations of any synchronous delivery mechanism imposed on a student population and learning environment that operates essentially asynchronously (Jafari, 1997):*
    - We realize that the NCIH is an attractive (and costly) synchronous delivery medium that brings with it many of the difficulties we would face in expanding and improving our distance education offerings. Asynchronous course offerings using the World Wide Web provide many advantages over live television (Jafari, 1997). Even with live, or synchronous, offerings, recent improvements in technology allow Internet broadcast of both audio and reduced-bandwidth video signals to anyone who has access to a phone line, a modem, and a standard computer (Grenquist, 1997). Of course, transforming current conventional courses to effective web-based courses is quite demanding of faculty time for development, and the resulting courses may demand more faculty time to support than most conventional courses.

We intend to address these issues continuously as we offer our program in the next four years in the face of a dynamically expanding technology, perhaps incorporating components of appropriate newer technology as we go in an unfolding hybrid of the current NCIH system.

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Biographical Information (All authors are affiliated with the University of North Carolina at Charlotte)

WILLIAM SHELNUTT is an Associate Professor of Manufacturing Engineering Technology and Academic Coordinator of Engineering Technology Distance Education Programs.

AMBROSE BARRY is an Associate Professor of Electrical Engineering Technology and the first instructor in the distance education program.

NAN BYARS is a Professor of Mechanical Engineering Technology and an instructor in the distance education program.

JACK CARTER is an Associate Professor of Electrical Engineering Technology and an instructor in the distance education program.

CHENG LIU is a Professor of Civil Engineering Technology and Chairman of the Department of Engineering Technology.

CONNIE MARTIN is UNC Charlotte's Director of Continuing and Distance Education.

TOM OWEN is Assistant Chairman of the Department of Engineering Technology, and an instructor in the Distance Education Program.

PATRICIA TOLLEY is Director of Special Programs and Faculty Associate for Mentoring Programs for The William States Lee College of Engineering.