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Satellite Delivery for Distant Learners: The National Technological University

L. V. BALDWIN*
National Technological University, 700 Centre Avenue, Fort Collins, CO 80526 U.S.A.

Engineering faculty in the United States have pioneered the use of instructional television (ITV). Satellite delivery has added significantly to both diversity and accessibility. The National Technological University, a cooperative effort of 31 major engineering colleges, today delivers instruction to more than 275 sites nationwide, including 65 corporations, 15 government agencies and 30 colleges. Over 6000 technical professionals have completed graduate courses in the first 3 years of operation, and 45,000 participated in short courses and tutorials in 1988–89. Annually, NTU offers 10,000 h of graduate instruction and 1800 h of interactive continuing education and research teleconferences.

COOPERATION PROVES EFFECTIVE

IN AUGUST 1974, representatives from two dozen colleges operating video-based programs, along with a sample of their customers, attended a workshop to discuss ways in which cooperation might improve continuing education service. Follow-up planning in April 1976 led to the formation of a non-profit consortium, the Association for Media-based Continuing Education for Engineers (AMCEE). Initially, 12 schools adopted the goal 'to increase the national effectiveness of continuing education for engineers'. AMCEE members share information on customer needs and encourage the publication of short video courses aimed at practicing engineers. AMCEE serves as a marketing cooperative to help reduce the distribution costs. AMCEE received start-up support from the Natonal Science and Alfred P. Sloan Foundations. The first AMCEE catalog, published in 1978, contained 172 courses from 10 universities; the current catalog lists over 280 courses from 30 schools plus the consortium itself. Member universities in AMCEE have grown from 12 in 1976 to 33 schools today.

The introduction of modern telecommunications to support shared advanced instruction for technical professionals nationwide has had a broad and lasting impact on US higher education. In a recent study of education in corporate America, Nell P. Eurich [1] concluded that 'engineers seem to be light years ahead of other professions in using media for education and updating'. It is therefore natural that engineering and computer science faculty were the first to explore satellite delivery.

* President of the National Technological University.

A SATELLITE NETWORK FOR ENGINEERING

By the early 1980s, AMCEE was filling many needs in continuing engineering education. The consortium's success strongly suggested that a place existed for a national university that taught students through the lastest telecommunications technologies. With increasing affordability of satellite communications, AMCEE's Board of Directors saw the possibility of extending the range of ITV systems to a coast-to-coast audience. Since less than half the engineering workforce was served by regional systems, there clearly was a role for satellites to play.

The universities in AMCEE believe that the cooperative approach is the best way to meet the demand for quality graduate and continuing education instruction. In February 1982, the AMCEE Board of Directors agreed to investigate the feasibility of creating a national engineering college that would deliver its programs through the most advanced satellite telecommunications technologies. The network would be shared by the universities and sponsors such as industry and government laboratories. The Board pledged $100,000 of consortium funds to the study. Fourteen industrial and Department of Defense sources added $370,000 to the planning effort. These sponsors provided technical advice and met regularly to help shape the plan over a 2-year period.

THE NATIONAL TECHNOLOGICAL UNIVERSITY

The National Technological University was established in Colorado as a separate non-profit, private educational corporation in January 1984. The NTU was created to award masters degrees in selected fields. The academic programs feature

approved courses of instruction offered by 26 participating universities, all members of AMCEE.

Each participating university evaluates and records grades for students completing its courses. The student grades are also posted by the NTU Registrar at the end of each term.

By using advanced educational and telecommunications technology to deliver instructional programs to graduate technical professionals at their employment locations, students do not need to leave the workplace to participate in the instructional programs.

Each NTU site is operated by a sponsoring organization (i.e. the company employing the student) following guidelines provided by the NTU. The courses are rigorous, but provide a convenient and flexible alternative to campus study. The NTU has the services of over 4500 full time engineering and computer science faculty members from participating universities, assuring high-quality instructional programs. Moreover, the NTU conducts research in areas of educational technology related to teaching and learning to ensure continued responsiveness to the needs of the students [2].

The NTU's functions are to:

- Award master's degrees to qualified individuals in selected disciplines.
- Provide research seminars in each discipline.
- Operate a modern telecommunications delivery system for convenient, flexible, on-site service.
- Offer non-credit short courses, tutorials, seminars, and research symposia to introduce newly advanced technology concepts to a broad range of technical professionals.
- Establish a sophisticated satellite network infrastructure between industry and the university communities.

The NTU began offering courses to more than 150 technical professionals in the Fall of 1984. Programs were distributed by video cassette. This first group of adult learners were employed in 14 sponsoring sites of Eastman Kodak, H-P, IBM, GE and NCR. Six universities taught 15 courses of the Computer Engineering graduate program. On August 28 1985, the NTU began satellite delivery and enrolments jumped dramatically. In Spring 1990, 24 universities delivered 145 courses to over 1700 enrollees from 65 corporations and 15 government agencies. The NTU ceased shipping cassettes in May 1985.

The NTU network is configured so that each instructor can simultaneously teach both on- and off-campus students. Specially equipped ITV classrooms, each with several remotely controlled color cameras and audio microphones, are the origination point of each broadcast. The ITV signal can be beamed instantly from each of the campuses to the satellite. The part-time students at their job sites can view the class live and, through telephone linkages, ask questions during the class session.

The interaction in a teleconferencing mode via satellite has been successful. Since the NTU credit classes are planned to serve an average of 40 off-campus students, classroom interaction between the teacher and off-campus students can be easily accommodated. For classes that must be delayed a few hours before being broadcast because of schedule conflicts, the NTU provides occasional time for recitation sessions done by teleconferencing. Videotape machines offer the student who must miss a session the opportunity to view it at a later, convenient time. Indeed, videotape is an essential part of all live ITV today—it adds a time buffer when needed as well as an opportunity for review.

The NTU ITV system employs the best available methodology evolved over the past two decades at the participating universities and other schools. However, the 3-h time difference between the east and west coasts, along with both schools and customers in each of the four zones, means that the NTU must increase the communications opportunities for teachers and students outside of classroom periods. Experiments are now underway with an electronic mail and computer conferencing service to supplement telephone interaction.

Each receiving site is equipped by the sponsoring organization with a TV receive-only station (TVRO). These installations generally cost less than $10,000 and consist of a 3.6 m antenna or dish (larger in some areas) with surface tolerance sufficient for Ku-band reception, plus two low-noise amplifiers or block downconverters and two tunable video/audio demodulators or receivers. Color monitors and several programmable 1/2-in. VHS recorder/players complete the receiving station equipment, which is often located in small, multi-purpose conference rooms at the corporate sites.

Each receiving site plays an access fee to join the NTU network. Some corporations choose to pay a corporate-wide fee, allowing all their US locations to participate.

After the receiving site joins the network, each enrollee is charged tuition and fees for each course taken. Each participating university sets the tuition for the instruction it provides in the NTU program. This tuition may vary from school to school. With the exception of three universities, tuition and fees in 1989–90 are $405 per semester credit hour and $305 per semester audit hour.

The NTU currently offers programs of study leading to the MSc. degree in seven disciplines. Students can choose from 550 approved courses in the 1989–90 *Academic Bulletin* in Computer Engineering, Computer Science, Engineering Management, Electrical Engineering, Manufacturing Systems Engineering, Materials Science and Engineering and Management of Technology. Curricula are regularly reviewed; new classes are added each year and some courses are revised or dropped.

Each matriculated student in an approved degree program is assigned an academic advisor

who has access to the student records through the interactive, computer-based record system maintained at the NTU. By Fall 1988, 350 students were accepted; in January 1990 that has grown to 722 with another 206 applicants in process. Fifty-eight degrees had been awarded by August 1989.

Each NTU Graduate Faculty in the disciplines offered conducts its affairs through annual faculty meetings, correspondence, and computer conferences as needed. Appointed representatives from each of the disciplinary Graduate Faculties serve on the Academic Executive Committee. This Academic Executive Committee considers and makes recommendations on academic affairs. Although the University does not grant tenure to faculty members, the academic organization clearly follows the traditional model, providing both the freedom and the responsibility to the instructional faculty to develop and maintain outstanding programs of study in advanced technical subjects.

The NTU is accredited by the Commission of Institutions of Higher Education of the North Central Association of Colleges and Schools.

PROGRAM EVALUATION

During the first week of class, each student receives a personal welcome letter from the NTU along with a self-addressed stamped return postcard. The return card is an early evaluation of video, audio, and camera-work quality. 'Are the lectures correctly identified? Did you receive the course syllabus, book, and supporting handouts?' Almost half of the students return these cards, providing an 'early warning' system. Faculty and ITV program administrators are sent the tabulated results and individual cards immediately. The actual mechanics from classroom-to-classroom are thereby evaluated for *each* course at *each* site *each* term. Problems are worked out early. The students also provide information on when they are viewing the lectures and this is sent to the instructors. In Fall 1989, they reported as follows:

At time of broadcast	22%
1–3 days after broadcast	54%
4 days or more after broadcast	24%

Near the end of each term, an independent evaluator, R. O. Forsythe of Purdue University, sends an instructor, course, and instructional system survey form to each student. These are collected and analyzed by Forsythe. This information is provided to each university for the courses offered by that school. The NTU uses these evaluations to plan improvements in the delivery system and to select teachers/courses in future terms. A reflection of overall student satisfaction can be gleaned from the 1988–89 Assessment Report

> Eighty-one percent of the respondents said that they are planning to take other NTU courses. The percentage of students planning to pursue an NTU degree also increased from 63 percent in 1987–88 to 69 percent in 1988–89. The majority of students in 54 percent of the NTU courses agreed with the statement that their instructor should receive an outstanding teaching award.

The principal problem that students report is the great time commitment required to complete the graduate classes. Virtually all students must maintain their regular job and family commitments, and squeeze in their graduate study. Furthermore, since most left college 5–10 years before starting NTU studies, they report that they must regain their study skills.

How do the employees evaluate the NTU? Since the number of sponsoring sites and corporations is growing rapidly, the bottom line must be good.

One corporation's internal evaluation concluded:

> There are many advantages to NTU. NTU has a large and varied offering of courses. These are of high quality content and are presented by very skillful professors. As a taped format, courses are flexibly accessed and allow a person to review the course material on their own as needed. NTU offers a variety of specialized courses not found at a single university. NTU allows many people who could not otherwise do so to pursue advanced studies at home and at work.

In the study cited above, technical professionals estimated that their effectiveness on the job had increased 25–35% as a result of completing the NTU graduate program of study. They also cited specific examples of significant project savings in money and time which resulted from advanced study.

SHARED NATIONWIDE ITV NETWORK

The time period from 11:00 a.m. to 5:00 p.m. EST on Channels A and B is reserved for non-credit, short courses, tutorials, seminars, research symposia and teleconferences. These are all offered live and interactively. Approximately 300 days of this special programming is delivered annually. Over 45,000 attended these programs in 1988–89; a 5-fold increase over the previous year.

Since April 1987, this career-long education program, which we call Advanced Technology & Management Program, has been organized into three regular series:

- *Technical Professional Development Series*. Two hours each Monday are devoted to increasing personal and organizational skills of technical professionals. Speakers are drawn from industry, consulting and universities. A different topic is offered each month in TPDS.
- *Monthly Feature*. The third Tuesday and Wednesday of each month is devoted to a topic of

current interest. Most are tutorials, but some are research symposia. Speakers are leading authorities from government, industry, consulting and universities.

- *Member's Choice*. The remainder of each month is devoted to a one-, two-, or three-day (rarely four) tutorial, research symposium, or teleconference. As the name implies, these are usually produced by the 29 consortium member universities who participate in the non-credit operation. Generally, Member's Choices are devoted to continuing education. There are important exceptions, however, when research is the focus.

Three examples illustrate NTU non-credit programs. The TPD Series in July–December 1989 focused on 'The High Performance Workplace: Leadership, Teamwork and Quality'. Each month had a focus. 'Technical Professionals as Leaders: An Evolving Role' in July had instructors drawn from Hewlett-Packard, NCR, a private consultant, and a faculty member. October was devoted to 'Commitment vs. Control in the Workplaces'. Instructors included staff of Eastman Kodak, Hewlett-Packard and a private consultant.

The Monthly Feature in November 1989 was a two-day symposium on 'Cross Functional Management'. Speakers included Charles E. Hutchinson, Dean of the Thayer School of Engineering at Dartmouth College; Joseph F. Kasper, Associate Director of the Cook Engineering Design Center at Dartmouth; Dan Dimancescu, Technology and Strategy Group, a science and technology management consulting firm: James F. Watson, Vice President of Texas Instruments Inc; Thomas G. Gunn, a consultant; J. Tracy O'Rourke, President of Allen-Bradley Co.; Robert J. Winner, research staff member of the Institute for Defense Analyses; Robert Johansen, Director of the Institute of the Future's New Technologies Program; Gerald A. Paxton, Vice President of US Sales for Digital Equipment Corporation; Peter Turney, Tektronix Professor of Cost Management at Portland State University.

Topics included: introduction to the concept of cross-functional management and its relation to current engineering management practice; review of quality control and quality improvement experiences in several industries; identification of new tools, techniques, and technologies required to implement cross-functional management; comparison of civil sector and defense-industry approaches to quality control and management; and discussion of new organizational structures, centered on quality and productivity improvement.

'User Interface Strategies '90' is an example of a Member's Choice program. The University of Maryland produced this on December 7 for user interface designers, programmers, software engineers, software evaluators, managers in the computing and communications fields, human factors specialists, trainers, marketing personnel.

Program organizer Ben Shneiderman, Head of the Human–Computer Interaction Laboratory, Professor of Computer Science and Member of the Institute of Advanced Computer Studies at the University of Maryland–College Park, spoke on breakthroughs in user interface design. Schneiderman discussed the battle over multiple window graphic user interfaces, the emergence of user interface tools, the rapid dissemination of hypertext/hypermedia, international competition on home controls and electronic consumer devices, and movement towards collaborative meetings and classrooms.

Today, these programs are attracting 700–900 attendees at 50–60 sites. Videotapes may be made and used for a 30-day period. Each program is supported by a set of notes and visuals delivered at least two weeks prior to the broadcast.

The average NTU charge per attendee at a two-day program in 1988–89 was $67. Furthermore, great savings are realized by eliminated travel and hotel bills and by minimal time away from work.

There are many advantages to building a strong national satellite network for technical professionals and technical managers. The NTU has worked with IEEE, AAAI, ASME, ACS, ASEE, DoE, ONR, Material Research Society and the Semiconductor Research Corporation. These relationships have greatly strengthened the NTU offerings and from the various societies' and agencies' point of view, provided them with a cost effective delivery system nationwide.

REFERENCES

1. N. P. Eurich, *Corporate Classrooms: The Learning Business*, Carnegie Foundation for the Advancement of Teaching, Special Report, Princeton University Press (1985).
2. L. V. Baldwin, *An Electronic University*, p. 108; *Instructional Television*, p. 110; *IEEE Spectrum*, **21** (11), November 1984.