Experiment U-1

"Tele-education"

CURRICULUM-SHARING VIA SATELLITE

FINAL REPORT ON THE STANFORD-CARLETON-NASA-AMES CTS DEMONSTRATION

Sharon
S. Strover

Stanford University

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a report of the

INSTITUTE FOR COMMUNICATION RESEARCH
STANFORD UNIVERSITY

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Sharon Strover
Institute for Communication Research
Stanford University

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I. Introduction

Communication satellites have captured the imagination of scientists and educators. Over the past decade, satellite technology developed to the point where a number of new, important applications seem feasible. These applications -- ranging from navigational aids for airlines to disaster area portable communication facilities to library networking -- have recently been subjects for experimentation in the U.S. and Canada.

In January 1976, the Communication Technology Satellite (CTS) was launched. A joint U.S.-Canada venture, this satellite embodies both technological and social advances: it is a high-powered satellite with more flexibility and capacity than satellites heretofore launched; it is the facilitating vehicle for many new service offerings in the fields of medicine, education, and community development.

One of those new services is curriculum-sharing between Stanford University in California and Carleton University in Ottawa, Ontario. Curriculum-sharing is not a new idea. For many years radio networks, public television, and correspondence courses have operated as curriculum-sharing devices. But not until communication satellites appeared on the scene did real-time educational outreach with feedback from students seem possible and potentially cost-effective. Satellites could allow two-way course sharing in contrast to other one-way course distribution systems. With the satellite's ability to deliver courseware to many students at the same time, cost factors which had seemed to prohibit using television for large-scale educational efforts faded. The Stanford-Carleton effort is an early investigation of curriculum-sharing via satellite.

These two universities exchanged engineering courses using CTS over six months, from October 1976 to March 1977. The National Aeronautics and Space Administration (NASA), U.S. sponsor of the CTS, participated directly in this demonstration via its installation at Ames. NASA-Ames engineered (literally and figuratively) the satellite experiment, undertaking overall management and coordination as well as designing and testing advanced video compression modulation and error correction equipment used in the demonstration.

The following pages document the progress and conduct of the Stanford-Carleton-Ames project. This report focuses on administrative dimensions for many reasons. Contrary to what many would like to believe, the utility of using technology in educating has been proved; educational attainment, whether achieved in face-to-face or television class settings, does occur. Hence learning *per se* is not a focus of this evaluation. Rather, planning, management, and administrative features are highlighted. As an evaluation of these dimensions, this document tries to pinpoint problems, failures, and successes. Economic, institutional and user group constraints were all encountered during the demonstration. It is the point of this report to explore those constraints, to provide for future users some insight into such problems so that they may solve them in the future.

The methodology for this evaluation, a case study in research style and reporting, is subjective. Personal records, interviews, and questionnaires were used to gather information. There is definitely subjectivity here. It is the social scientist's duty to recognize this subjectivity and bring it into the open.

As a researcher I functioned as something in between a participant and an observer, unable to completely adopt the perspective of those studied, yet also unable to remain completely detached from day-to-day procedures involved with the project. The only satisfying perspective for me seems to be to own up to the fallacy of objectivism and to attempt to lay bare my methods. Hence, I have tried throughout to attribute my conclusions and observations to their sources, and to explain my logic.

The three-party curriculum-sharing experiment followed a short history of U.S. communication satellite experimentation, the results of which always edged scientists out into the fringe of technological capabilities and users — that loose group of visionaries — into the halls of NASA to plead for opportunities to joust with these expensive devices. As studies with various educational delivery systems seemed to show that medium could affect content but probably not substantive learning, the idea of satellite-delivered education began to take shape. Developing countries particularly studied feasibilities for satellite-distributed schooling across their rough, untamed terrain to widely separated populations.

The present experiment is not novel in its conception; however it is unique in its accomplishment. As an experiment, the curriculum-sharing effort has many problems; that the demonstration "worked" at all was a surprise to some, given that most funds for the demonstration went for hardware, and only negligible amounts were devoted to management, planning and courseware. It is thus not surprising that technically the demonstration succeeded, but that as an exercise in the pragmatics of curriculum-sharing, it left much to be desired.

This report details insofar as possible the elements of the Stanford-Carleton-NASA-Ames project concerned with administering, coordinating, and conducting the course sharing.

II. Methods and Procedures

There are several methodological difficulties inherent in this study. First, classical evaluation requires a baseline set of goals against which one is to measure a project's progress. Although this experiment did pose goals before actually getting underway, the conduct of the experiment was geared more toward simple day-to-day workability rather than any systematic, well-planned procedural testing of instructional techniques or strategies to best resolve administrative/economic problems. Hence, any evaluation of the project must have a hard time focusing on relevant comparisons between the reality of what happened and paper planning. Therefore, I have adopted a case study approach which may serve to illuminate the project's successes and failures through chronological description and overview.

Secondly, in gathering information, my role necessarily could not be one of a passive observer. Typical of any "in-house" evaluative effort, my record is biased and not objective. I was frequently pulled into the role of advocate, representing the project at one professional meeting and helping to pinpoint soluble problems rather early on. In this sense, my work took on some small aspect of formative evaluation: my early findings were fed back into the system, some small adjustments made perhaps. I was not only a "data collector" but rather an "observer participant" as the sociologist Denzin (1970) would characterize my position. This chronicle is of course colored by this unique perspective.

Third, it must be admitted that I find it difficult to "social scientize" this report. Insofar as this is a case study based on fairly extensive

present at one or more of these sessions; and I solicited feedback from all (see Appendix B for sample agenda of one teleconference). I randomly sat in on several of the Carleton courses to observe student behavior and interactions between the Stanford and Carleton sites. The file documents I reviewed included NASA-Ames' official log of project status, memoranda and letters. Professor Parker's files provided some information on the project's development from a technical concept to a curriculum-sharing demonstration and included many ideas for evaluation planning. Ken Down's files included letters, memoranda and records of project planning meetings. These noted people contacted, decisions proposed and executed, the experiment's problems and progress, and indicated what sorts of management communication patterns were at work. In addition to my formal interviews, I had numerous informal talks with people involved in the demonstration, particularly Ken Down, Allen Peterson and Larry Hofman, throughout its duration.

Everybody I contacted on the administrative level was very helpful and encouraging. However, nearly everybody with whom I spoke had something of a "vested interest" in the experiment, since each was directly involved in it. This necessarily biases their -- and my -- interpretation of events connected to the project.

Considering the purpose and focus of this case study, (1) given that the curriculum-sharing project was more of a demonstration than an experiment and (2) given that I was more interested in conduct and utility of the satellite system rather than the educational system (how well the instructional technology "taught"), I decided to limit my examination to administrative aspects of the project. I selected key administrative procedures embedded in a more general administrative process, bringing into consideration such elements as attitudes toward the experiment, morale, general funding commitment, etc.; and I examined which elements contributed to success, which did not, and why. I also uncovered cost categories relevant to this project, my intent being to project some financial considerations for operational systems.

III. The Context of the Curriculum-Sharing Project: A Brief Review of Social Applications and Experimentation with Satellite Systems

The current and potential capacity of communication channels has been drastically increased by the existence of communication satellites. In the U.S., domestic satellites are now private entities, generally operating as "telephone lines" for fairly traditional communication services -- data transmission, computer links, private phone circuits, and the like. The educational community over the past decade vigorously lobbied for access to satellite distribution modes for the purposes of offering educational opportunities to more people and to more locations, taking advantage of satellite delivery's possible cost savings, and facilitating a sharing of personnel and resources. However, the prevailing commercial satellite formats prohibit, largely for cost reasons, educational programs.

Experimental satellite opportunities, sponsored by NASA or, in the cases of the Applications Technology Satellite-6 (ATS-6) and the Communication Technology Satellite (CTS) (dubbed Hermes by Canada), by NASA in conjunction with other countries' space organizations, naturally prompted several educational organizations to apply their ideas, to test the viability of satellite distribution of various services. Stanford's experiment with Carleton University is one such test, utilizing the unique opportunity of this high-powered experimental satellite, the CTS, to explore aspects of curriculum-sharing.

Experiments in communication satellite applications have been conducted, strictly speaking, since the first such satellite, Echo, was launched in 1960 to counterpoint Russia's Sputnik. However, users interested in social applications, rather than phone links or data transmission, etc., got their first crack at satellite experimentation with NASA's Application Technology Satellite (ATS) series which began in 1964 (although the first launch was in 1966).[1] NASA was interested in furthering the technical sophistication of this technology, and a community of users was anxious to test those uses of satellites particularly adapted to the technology's biggest advantages -- reaching remote regions inaccessible by other communication modes and potentially cutting transmission costs. Over the years, ATS-1, ATS-3, and more recently ATS-6 have been used for a variety of experiments; educational, medical, library and teleconferencing experiments have been performed, predominantly in the U.S. but in other countries as well. (ATS-6 was shared by the U.S. and India, and CTS is shared by the U.S. and Canada; other satellites such as Symphonie, the French-German communication satellite, have also facilitated experimentation for social applications.)

The implications of satellite technology for education are mixed. On the positive side, satellites seem to offer opportunities for curriculum-sharing among schools, remote instructional delivery, remote teleconferencing with sources of expertise, remote services such as counseling or library linkages so that schools with extensive facilities can be exploited by less well-endowed institutions, increased opportunities for continuing education (especially if satellite systems are linked with cable systems), and national (or transnational) linking of special interest groups. Satellites offer the chance to spread costs across a large number of users.

On the negative side, satellites are high technology, and capital intensive. The potential for abuse by a controlling power is great, given the technological requirements inherent in satellites: heavy initial investment, central technical control (for at least mere operational matters), and sophisticated maintenance and troubleshooting personnel backing up the system.

But aside from the positive or negative aspects of communication satellites, potential users are still questioning the viability, costs aside, of satellite systems used for education. That television can "teach" is a given, but educators want to see if the linkage itself could perform adequately; they want to determine if instructional TV via satellite could be easily assimilated into existing educational settings and formats; people also want to explore the problems of scale -- setting up multiple point services and facilities, and getting them to perform well for the community of users -- inherent in cost-effective satellite use. Experiments using ATS-6 and now CTS have focused on projects of longer duration and have employed more realistic settings than heretofore. India, Canada and the U.S. each tested or demonstrated satellite applications for their specific needs.

India, focusing on the potential of satellite for fostering national development, initiated its Satellite Instructional Television Experiment (SITE), which beamed educational television to multiple semi-remote locations in four languages; programming content aimed at health education, traditional education, and entertainment (Singh and Jamison, 1973).

Canada's current experiments on CTS are relatively small-scale demonstrations, proposed and implemented, with the national Department of Communication's (DOC) help, by specific educational or government or special interest groups. The DOC, in contrast to NASA, provided satellite terminals and other hardware for experimenters. Because this equipment had to be shared among the demonstrations, Canadian experimenters had to settle for projects of limited duration. Their content areas range from medical and health service delivery for remote areas to interregion two-way radio for northern Canada natives (Casey-Stahmer, 1977).

The United States' experimentation with more advanced high-powered satellites has been the most extensive of any country's. As technological systems for spacecraft grew increasingly sophisticated, concommitantly, ground technology required less sophistication: the concentration of power and beaming accuracy of the satellite itself compensated for less powerful and less accurate ground antennas (Hudson, and others, 1975; Lusignan, 1976). Hence instead of the elaborate tracking and receiving systems which characterized earliest experimentation à la Holmdel, N.J. (a Bell Telephone outpost instrumental to much early communication satellite experimentation), antennas for ATS-6 and CTS have been as small as eight feet. They can be directed by crude techniques acquired in a short period of time by laypeople. More highly-powered satellites paved the way for increasingly flexible (and mobile) applications; antennas could be moved and quickly set up; ground technology at remote outposts was simplified and more easily deployable. U.S. experimenters have taken advantage of these advances, for example in Alaska where laypeople directed their own antennas, and among navigational interests (e.g., the Coast Guard and U.S. airlines) who tested mobile transmissions provided via satellite. One CTS experiment sponsored by Comsat Laboratories explores terminal mobility and adaptation to disaster situations.

Yet, it has not been easy for users to experiment with social applications of satellite technology. Whereas during the sixties the impetus of the "space race" and President Johnson's advocacy of space achievements carried technological developments to the point where certain applications for communication satellites seemed feasible (i.e., costs were coming down in ground terminal equipment, multiple access capabilities for satellites existed, new frequencies were tested), a number of factors intervened to stifle exploitation by potential users. Probably the foremost of these was commercialization of communication satellite technology: with the technology transferred to the private sector in 1965 via the Communication Satellite Act, NASA's role in further research and development was questioned.

First, NASA is prevented by mandate to engage in any operational activity:[2] with communication satellite technology successfully transferred to Comsat and Intelsat, NASA had problems justifying its intentions to continue R&D in satellites.[3] Secondly, a new administration in 1968 was much cooler toward space exploration and applications than was President Johnson's.[4] Third, with a tightening of federal funds backing user experimentation, those experiments which <u>were</u> performed adopted a quasi-operational mode (for example, PEACESAT, and the Alaskan Medical experiment) which more or less safeguarded investments already made.* This was exactly what the civilian space agency is supposed to avoid.

By the time NASA formally redefined its user program for communication satellites in 1973, however, a number of "experiments" -- actually demonstrations -- had taken place.[5] Building from the Ford Foundation's 1966 proposal that the FCC authorize a new corporation to distribute satellite television programs with free channels for educational TV, educational user groups from universities and foundations, government offices such as the Department of Health, Education and Welfare (DHEW) and the National Library of Medicine and the U.S. Information Agency, as well as private companies still waiting to capitalize on the domestic satellite market ("domsat" legislation had yet to be approved) attended meetings and sponsored proposals for communication satellite applications.[6]

Experimentation began when the Corporation for Public Broadcasting relayed educational television from the east to the west coast between January 4 and March 26, 1970 via ATS-1; the Law Enforcement Assistance Administration (LEAA) conducted fingerprint transmission via satellite in California and Florida to test a new identification procedure in December 1971 using the ATS series of satellites; maritime and air navigation and traffic control satellite experiments were sponsored by such diverse groups as the Maritime Administration, the U.S. Air Force, the U.S. Navy, the Netherlands Coast Guard, the Federal Aviation Administration, and the national airline companies; in Alaska, where the inaccessibility of many regions, the severe geographical and climatological barriers and a sparce, dispersed

*Investment refers to capital as well as time spent developing a routine system.

population had prohibited regular commercial communication services, ATS-1 was used to demonstrate the feasibility of a satellite radio-based health network to broadcast a cultural series, "Crossroads in Time", about life with the Athabaskan Indians of interior Alaska and to transmit other programs on a regular basis; the University of Hawaii sponsored PEACESAT (Pan Pacific Education and Communication Experiments) in 1971 to network educational radio to islands in the area via satellite; library networking and teleconferencing (voice only) were also demonstrated.

With ATS-6, larger scale projects were tried. Alaska, the northwestern states, Appalachia and the Rocky Mountains were targeted for satellite-based services. In Alaska educators mounted an oral language-development course for children aged four to seven, a health education series, and a topical series for adults; most of the eighteen total sites were rural Alaskan native villages. Another Alaskan experiment, the Indian Health Service Experiment, investigated the utility of teleconsultation between local clinics and a regional hospital. An effort to regionalize medical education took place in Washington, Alaska, Montana and Idaho under the acronym of WAMI. Since this area of the country suffers from a dearth of medical schools and facilities, these states used the satellite to expand educational sites for medical students, and to link administrators, counselors, and managers among area universities and clinics. In the Rocky Mountain region, an educational demonstration provided career education for junior high students, teacher training, and an adult evening television series. Two projects undertaken in Appalachia focused on (1) continuing education for teachers (under the Appalachian Regional Commission) and (2) two-way communications of varying content and audiences for Veterans Administration hospital staffs. The latter developed video seminars, out-patient clinics, teleconsultations and other service programs (Filep and Johansen, 1977). Clearly ATS-6 was a major step in large-scale planning for satellite users. Most were sufficiently enthusiastic about their results to attempt to continue or elaborate their programs on CTS.

With the 1973 NASA decision to phase down in the communications area, the Communication Technology Satellite (CTS) may well be the last experimental satellite available to users. In 1971 Canada and the U.S. agreed upon the CTS Program.[7] Canada designed and built the spacecraft, and the U.S. provided launch services. Formal division of responsibilities provided that NASA supply (1) a Delta launch vehicle and launch operations (2) a high-power travelling wave tube amplifier and its power conditioner (3) facilities for spacecraft environmental tests (4) ground facilities for tests of the new high-powered tube (5) share 50% of the experiment time and co-investigate the technology; Canada provided (1) the spacecraft (2) the apogee motor (3) orbital operations of the spacecraft (4) ground facilities in Canada for the experiments and (5) shared the experiment time and technology experimentation with the U.S. (Franklin and Davison, 1972).

While Canada was able to help its users plan their experiments and in many cases to provide facilities, funding, and expertise, the U.S. experimenters solicited their own support; many relied on other government agencies, notably DHEW, for support.

Experiments currently underway via CTS in the U.S. include attempts to provide education to teachers and health care workers and other professionals, portable terminal demonstrations (under the Red Cross and Comsat Laboratories), library networking, and video teleconferencing (Westinghouse, NASA, George Washington University/Congress), and investigations into link characterization (Goddard Space Flight Center), small terminals (Goddard Space Flight Center/NHK), and other demonstrations (Public Service Satellite Consortium, National Women's Agenda).[8] Unlike many previous satellite experiments, most of these involve video and audio links, many incorporating simultaneous two-way video -- or at least two-way audio.

The Stanford-Carleton-NASA-Ames experiment blended technical considerations with administrative questions. Insofar as it was the only experiment utilizing compressed digital video, a method permitting a TV signal to be transmitted with only a fraction of the bandwidth and power normally required, there was a technical acceptability question. Additionally, since the satellite component really did not introduce anything new in terms of televised instruction, this experiment focused on organizational and technical considerations pertinent to satellite-delivered curricula.

Hence, within the larger context of satellite applications as they have developed over the past decade, the CTS curriculum-sharing experiment was innovative in many ways: it tested compressed video techniques; it integrated experimental courses* into an ongoing university curriculum;

it copied with day-to-day problems of administration, course materials exchange, and instructional television across two educational sites.

*The courses were only experimental insofar as they were being sent to or received from another university. Otherwise, they were established items within the curriculum.

IV. Educational Delivery Systems: Is Content Affected by Medium?

One of the questions people ask repeatedly of satellite experiments concerns the effect of the medium on content and learning of content. It was the Stanford-Carleton experimenters' position that the satellite did not constitute a medium (McLuhanism aside); rather, it was merely a mode of communication: televised courseware is televised courseware whether delivered via cable, terrestrial microwave, satellite, or closed circuit. Hence, the demonstration's design never tried to consider isolated effects of the satellite on the learning process or content delivery. Additionally, the experimenters felt that graduate students, the target of the courses, had sufficient motivation to overcome learning impediments posed by technical problems. Their desire to learn would probably reach beyond any system limitations. Hence, the curriculum-sharing demonstration did not wish to consider the system's effect on learning.

Research has shown limited effects of instructional technology on learning. According to Wilbur Schramm, a researcher who has examined the effects of instructional technology more than anyone else, television instruction compared to classroom instruction evokes no significant differences in learning from the two sources: "...students can learn a great deal from any of the media. Under most conditions tested, they could learn as much as from face-to-face teaching about many subjects." (Schramm, 1977, pp. 34-35).

Schramm also considered whether so-called Big Media (e.g., instructional television and film) are more successful than Little Media (i.e., slides and radio). Such a comparison is clearly outside of the purview of the curriculum-sharing experiment, but it may be parenthetically mentioned that Schramm concluded Big Media have no inherent superiority over Little Media for teaching purposes (Schramm, 1977, pp. 33-34).

The most appropriate means to study the effect of satellite television is probably through implementing what Dr. Michael Ray has called "microtheoretical notions" (Ray, 1975). Just as it sounds, microtheory moves away from grand broad-reaching conclusions and hones down specific circumstances, audiences, and effects. Ray would argue that instead of examining relative effectiveness of satellite-delivered engineering courses to graduate students at Carleton and Stanford universities, and compare those results only to similar cases in order to make any conclusions.

But, to reiterate, this was not a focus of the CTS demonstration. That students <u>can</u> learn from media -- any media really -- was enough proof to undertake the experiment. It provided sufficient credibility to the underlying premise of the Stanford-Carleton experiment, which was that the satellite mode or television medium should <u>not</u> be subject to another inquiry of <u>legitimacy</u> for teaching purposes.[9]

Unfortunately, what the early experimental plans <u>did</u> intend to do went unfulfilled: early Stanford proposals considered incorporating variations in styles of presentation; panel discussions, student presentations, films, and demonstrations would alternate with more typical lecture format. Such attempts would have provided interesting comparisons, working toward a microtheory which would identify the strengths and weaknesses of a given medium (ITV) used for specific course material (essentially engineering). Important and interesting questions may have been answered had such variations ultimately been incorporated into the experiment's plan. The following questions suggest the original interest in varying presentation methods: [10]

a. Is there any meaningful difference in quality of the picture as a result of using digital compression?

b. How effective is two-way audio? Do students tend to make use of the capability? How important is it to their learning ability and their feeling of participation in the class?

c. What is the value of two-way video, particularly for student counseling and problem sessions?

d. Do viewing students feel more or less comfortable if they can also see other students in the classroom with the professor giving the lecture? Does the flexibility of two-camera coverage improve instruction sufficiently to offset increased cost? Does a front camera showing the audience make a significant improvement?

e. What techniques are effective for follow-up of televised lectures, including student assignments, classroom experiments and demonstrations, problem sessions?

f. Is a dialogue on a course subject between professors and students at the two universitites an effective way to make television instruction more "real" and therefore acceptable to students?

g. How much more effective is a lecture via televison if prepared with the television audience in mind? For example, does frequent explication by film (of a demonstration, perhaps with a time-lapse involved; of a historical event; of an interview with an expert on the subject; of animated information) serve to improve student interest and retention?

Such tests are exactly what Schramm does identify as needed research. He has criticized traditional examinations of television's relative effectiveness compared to face-to-face teaching, noting that "...the concentration of media research on television reflected in part a search for the super-medium." (Schramm, 1977, p. 36). He recognized that "...it would have been more useful to have a larger number of micro studies--trying to identify the unique strengths and weaknesses of a given medium for a given purpose, trying to maximize the learning from a particular medium and thus considering how it is used and how it can be used best." (Schramm, 1977, p. 36). His thoughts thus run parallel to Ray's.

Unfortunately, the demonstration at hand did not meet these intentions, and no experimentation with presentation styles took place because no funds supported it. As I have tried to indicate, varied presentational styles might have contributed greatly to our understanding of the relationship between content and medium.

In summary, the planned demonstration was directed toward an interesting and potentially quite fruitful program of investigation, moving toward micro-theoretical ideas about television and content presentations. It correctly dismissed needless questions comparing ITV to face-to-face teaching. The fact that lack of funds prevented the experiment from examining the effect of variable presentation styles is a loss.

V. The Stanford-Carleton-NASA-Ames Curriculum Sharing Project

A. Early Planning

The curriculum-sharing project between Stanford University and Carleton University grew out of a technical concept developed at NASA-Ames. Essentially, technicians and scientists perceived upcoming problems with broadcast satellites. Looking far into the future, they realized that the favored equatorial latitude "parking space" for synchronous satellites would be filled at some point; with a finite number of satellites that could be accomodated, the problem of nonavailability of space seemed imminent.[11] The logical counteraction was to develop not only spacecraft that would operate at higher bands (as the CTS does) but also to develop a way of sending signals in a more compressed, economical fashion. High-powered satellites constrain the bands' lower boundary. Digital communication techniques which would transmit a signal in a more compressed manner seemed to answer this difficulty, reducing power and bandwidth requirements.

When Research and Development at Ames developed the compressed video, and concomitant applications for real time TV, it was apparent that an experiment was needed.[12] Since NASA's policy at the time dictated an emphasis on <u>applications</u>, programs and projects which could be used by private enterprise or laypersons and groups, Ames searched for applications and users, and stumbled upon CTS, the experimental high-powered communication satellite co-sponsored by the United States and Canada. The group at Ames, including Dale Lumb and others set about developing an experiment. Through personal contacts in Canada, largely at Carleton University, the idea for a curriculum-sharing project emerged. Dr. Don George and Dr. John DeMarcado, involved in Carleton's "Wired City" Laboratory (a project originally intended to link Carleton, the city of Ottawa and some government offices via cable for educational programming, currently used to explore interpersonal aspects of teleconferencing) were enthusiastic and began planning an experiment.

By November, 1972, a project was proposed to NASA and the Canadian Department of Communication on behalf of interested participants at Ames, Stanford and Carleton.[13] Since Stanford had a routine instructional TV fixed service (ITFS) system, and since Carleton had the "Wired City," participants felt that it would be easiest to integrate extant television systems into the satellite experiment.[14] The experiment idea conformed to NASA's Opportunity Announcement which solicited proposals in the area of information networking, and curriculum-sharing seemed an appropriate area in which to begin research on information networking.[15] However, a primary focus was to be on video compression techniques: i.e., the scientific/technical aspects were emphasized over institutional or educational aspects of information sharing. The two schools and Ames proposed the linkage diagrammed in Figure 1.

Initial commitment came from Drs. Bowen (specialist in digital systems design), David Coll (manager of the "Wired City" Laboratory), and Donald George (Dean of the Faculty of Engineering) at Carleton; Drs. Alan Peterson (Engineering faculty) and Edwin Parker and Heather Hudson (Communication Department) at Stanford; and Dr. Dale Lumb of NASA-Ames. Stanford's representatives, expanding original plans, wrote, "we plan to examine

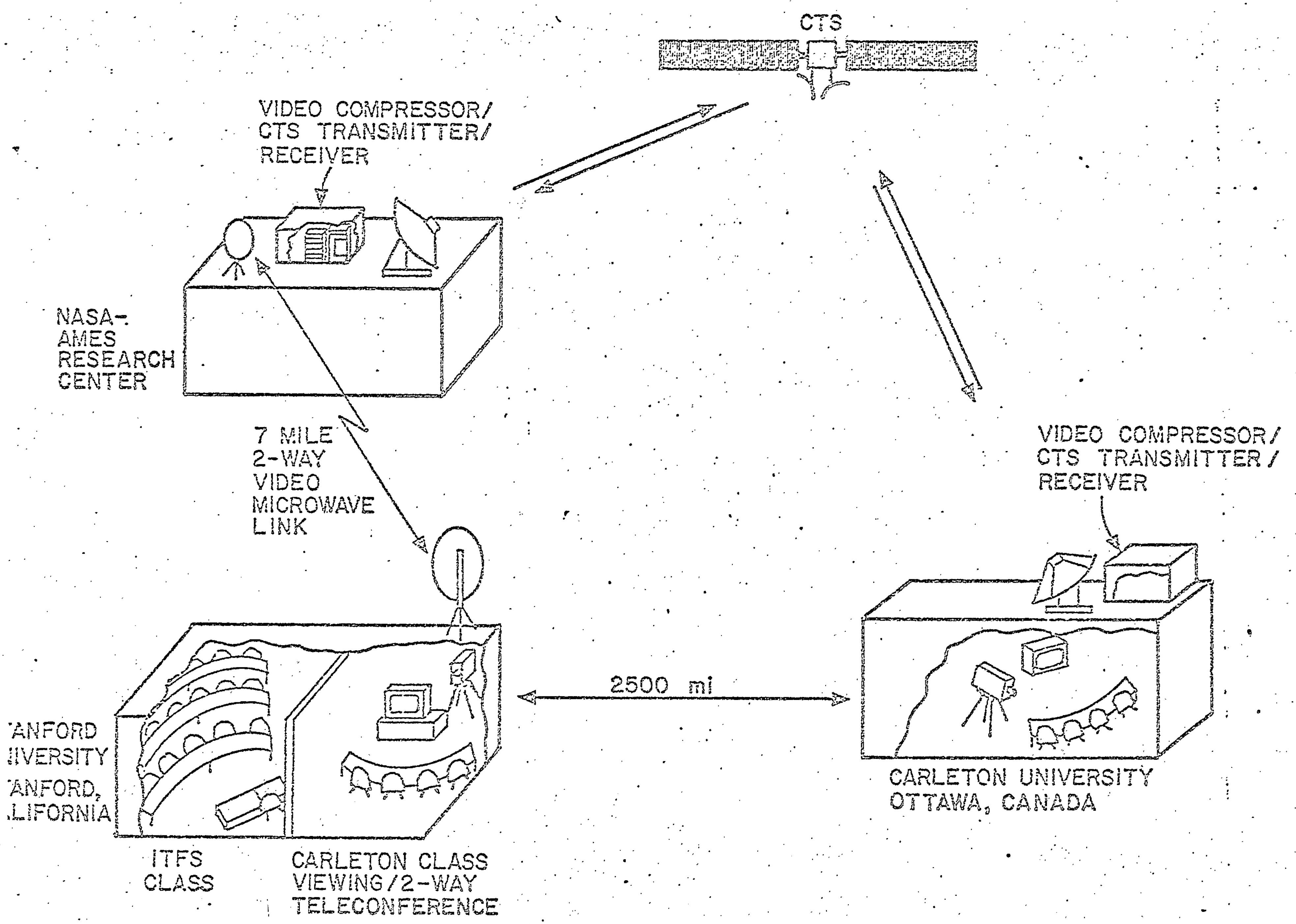

Figure 1. Curriculum-Sharing Link Via CTS.

user aspects of video teleconferencing with emphasis on the use of video compression including the economic impact on teleconferencing networks and the subjective quality of different video compression hardware. In addition, we also propose to investigate new techniques specifically directed at the television medium for enhancing the instructional process including live audio and/or video feedback and use of film and slides."[16] Three objectives in the joint proposal were listed: (1) to demonstrate the ability to expand the scope of instruction by sharing classes between universities with different emphases and orientations, (2) to develop optimum class presentation and student/teacher interaction techniques for remote curriculum-sharing, and (3) to develop, demonstrate, and evaluate a cost-effective digital video compression system in conjunction with efficient channel coding and modulation.[17]

This proposal was submitted to NASA and to Canada's Department of Communication (DOC), since both countries had to approve this international experiment. Obviously, the focus of the experiment had by now broadened somewhat from a merely technical development project to one incorporating investigation of various institutional, economic and educational goals.

It required five months for provisional project acceptance.[18] Feedback from the government agencies involved revealed some qualms about the time requirement of the proposal (two hours every day, five days a week), some technical questions (Carleton's audio feedback), queries regarding the availability of appropriate equipment, and particularly on NASA's part, inquiries on funding plans. This latter concern stemmed in part from the then-recently adopted NASA policy of phasing down in the communication satellite area and the collateral commitment to motivating users to find funds from non-NASA sources.

NASA-Ames contracted to develop the requisite hardware, notably the processing hardware and the quadra-phase modem. Linkabit in San Diego was to build the processor, and Stanford Telecommunication Inc. was to build the modem. Responsibilities at the two universities concerned developing the curriculum-sharing portion of the experiment and arranging for the appropriate equipment linkups for satellite broadcast. NASA furnished Stanford a microwave link to NASA-Ames which would transmit to the satellite, and Carleton had a terminal, loaned from the Canadian Communication Research Center (CRC). Both universities had to add hardware for the experiment. Both were also to undertake evaluation. Surprisingly, there was no formal written document which established separate responsibilities. In fact, NASA-Ames representatives stated that the presence of such a document would probably have had little impact on the conduct of the experiment.[19] Each party felt "in control" of its portion of the experiment -- a feeling which later possibly contributed to lack of communication among the three parties.

NASA-Ames shouldered primary responsibility as far as NASA-Headquarters requirements.[20] As it turned out, Ames facilitated or engaged in most of the communication among the three participants.

There were only two face-to-face meetings during the planning of the technical aspects of the experiment between Carleton people and the Ames staff. On August 20 and 21, 1973, Dale Lumb of Ames and Michael Sites of Stanford, Messrs. Coll and George of Carleton, and Mr. Durr of the Doc, and John Davies and Doris Jelly of the Canadian Communication Research Center

(CRC) as well as Pat Donoughe of NASA-Lewis (an adjunct to Headquarters in administering the CTS experiments) met in Ottawa. They reviewed the experiment's objectives, technical requirements and funding, scheduling times, and began preliminary discussion on course content and accreditation procedures.* They planned to share one graduate course from each university in video with voice return to the originating site; there would be one day a week for full duplex video between both schools in teleconference mode with special lectures. The Ames staff also viewed the Wired City Laboratory set-up, deciding the facilities seemed adequate to the experiment's purposes.

Responsibilities were further defined as a result of this meeting. In correspondence to NASA, Ames summarized its responsibilities as development, testing and implementation of the digital video system; Stanford was to engage in "detailed planning of the college curriculum-sharing programming, experiment procedures, and experiment evaluation techniques."[21] Ames also noted that Stanford was in the process of seeking funds from the Department of Health, Education and Welfare (HEW) for experiment support. The Canadian Project Office was providing the radio frequency portion of Carleton's ground terminal, and its digital video subsystems were funded by the DOC.

Also at the August meeting participants agreed on a testing period during June and the first half of August 1976 to work the "bugs" out of the systems. Projected hardware costs, reviewed by Lumb, were:

channel coder-decoder	$20,000
QPSK modem	20,000
video compression coder	25,000

*As it turned out, accreditation was merely a matter of requesting it with the Dean of Engineering at Stanford. No bureaucratic decisions or "red tape" hindered the matter.

It was clear that Carleton would have to buy equipment; funds for this were found from Carleton's in-house resources. Other technical arrangements concerning channel coding, technical aspects of the return voice channel, the IF interface, and spacecraft compatibility were discussed.

Nine months later the second meeting occurred when David Coll and Don George visited Ames Research Center and Stanford for two days of coordination meetings. No problems or changes were encountered, and there was consensus that the experiment seemed to be on schedule.

B. Equipment Acquisition

As of the middle of 1974, equipment delays began. Ames' time henceforth was taken up by (1) tracking down its equipment, testing it and making necessary alterations and (2) coordinating technical arrangements with Carleton and Stanford.

While Ames focused on technical arrangements, Stanford was to have been arranging the curriculum end of things. Yet Stanford never had a full-time administrator for the project, nor was any one person officially delegated to take charge of the project. This was to be a problem at Stanford. Efforts to find funding for its participation never did succeed; Parker and Hudson, and later Ken Down of Stanford's Instructional TV Network all contacted possible sponsors, with no success.[22] Personnel at the National Institute for Education (NIE) and the National Science Foundation (NSF) were contacted in 1974, they being the most promising sources for support. However, informal feedback revealed that funding for satellite experiments was a low priority.[23]

NASA-Ames did grant Stanford $8,000 to conduct pre-tests on technical quality of compressed video. During June 1975, Dr. Heather Hudson ran some tests using Stanford's network and the NASA-Stanford microwave link to transmit compressed video and assess acceptability levels for picture quality (Hudson and Strover, 1975). Later in November 1975, Richard Zachon of Stanford's Institute for Communication Research also ran evaluative tests of compressed video (Zachon, 1976). This was the only direct funding the experiment ever received on Stanford's end.

In any event, 1974 was still a time of predominantly technical planning, with Ames and Carleton ordering their equipment. By November 1974 Ames reported that it had 50% complete installation of the Ames Research Center control, monitor and teleconferencing facility; they ran some preliminary tests the following month. The next year saw several delays in component delivery and development; this of course caused hold-ups in assembly, integration and testing of the facilities.

By August 1975 the Ames staff realized that the video compressor needed substantial modification to produce a picture of acceptable quality. Meanwhile, Carleton's equipment installation and testing was not much further ahead. There were plans in December to test CRC's RF terminal, and the Carleton digital subsystem the following month -- the same month as the planned satellite launch. As it turned out, Ames redesigned and modified the video processor, completing the work in August 1976; Carleton's loaned terminal did not arrive until July 1976. Hence there was little time to de-bug or to simulate the curriculum-sharing mode.

C. Course Planning

The most significant development at Stanford during 1976 was the involvement of Ken Down, head of the Stanford Instructional Television Network. Hudson and Parker had felt from the beginning that Down's involvement in the experiment was crucial. Not only was Down known as an excellent administrator, competent at whatever he does, but he also would inevitably be involved in the experiment insofar as the instructional TV system would be broadcasting Stanford classes through the Ames link to Carleton. Down accepted certain duties in the experiment immediately; however, when he realized later in 1976 the enthusiasm and commitment of the Canadians at Carleton, and the wide attention the experiment was receiving, he was somewhat surprised: what had seemed to him a relatively low-budget, low priority exercise suddenly assumed major proportions. It was a somewhat unwelcome revelation, since Down was not funded for his efforts, and since the work of his staff in altering the TV system to accomodate the needs of the experiment went financially unrewarded. Nonetheless, Down accepted administrative responsibility for the experiment and became its main organizer at Stanford. It was clear by late 1975 that no one else at Stanford seemed prepared to do so: Dr. Parker was then on sabbatical; Dr. Sites had gotten another job; Lumb, too, had additional responsibilities outside the experiment; Dr. Hudson was away. Dr. Allen Peterson, the co-principal investigator from Stanford, was an engineering professor who aided Down but did not assume primary responsibility for day-to-day operations and problems.

By November 1975 Ken Down began to initiate Stanford's discussions on nitty-gritty items such as which courses would be exchanged, and who would teach them. The two schools were still then trying to decide whether to use full duplex (two-way voice and video) course delivery or instead, to try two-way simultaneous class transmissions with just audio return. The latter was agreed upon shortly.*

In February 1976 Ed Parker, Dale Lumb, Allen Peterson, Don George, Mike Sites, Thomas Kailath and Ken Down met together at Stanford to talk about administrative problems; scheduling and course selection and selection of professors still had to be decided. By April the two universities had tentatively selected their desired courses, and set up a schedule for course exchange. Scheduling was something of a problem since Carleton has a semester system while Stanford runs on the quarter system. As things turned out, the satellite itself had profound effect on scheduling since technical difficulties developed, causing a blackout to be imposed on its use from August 30 to October 18.** Hence both schools adapted to the satellite's availability although not without significant sacrifice, as will be described later.

Problems with the satellite were noticed in early March 1976 at the beginning of a solar eclipse. CTS project management wanted a lengthy blackout period to study and solve them; it also began to plan for a blackout period during other eclipse times when experiments were to be conducted. The curriculum-sharing experiment participants worried lest the eclipse blackout interfere with the conduct of the experiment. Dale Lumb informed Wasyl Lew, CTS coordinator at NASA-HQ, that if the satellite was turned off during the experiment's time, the curriculum-sharing demonstration would

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*Down also initiated contacts with the FCC concerning earth station application requirements for the satellite experiment, using the ITSF station's attorney as liaison. He was concerned about the station's rebroadcast liabilities.[24]

**An earlier blackout was imposed from March 4 - April 14, 1975. Between April and September, the satellite was used primarily for equipment checkout.

cancel.[25] CTS management agreed not to turn off the satellite at those times which would seriously interfere with experimentation. The satellite was not available until October 18. Therefore, the courses began on mailed videotaped lectures.

To return to the late stage of planning, a number of decisions regarding course selection and format and responsibilities were made in the summer of 1976. Course selections were firm as of June 1976. Stanford wanted Carleton's Computer Communications Systems I and Digital Systems Architecture in the fall quarter taught by Drs. Archibald Bowen and Ulug, respectively. In winter a follow-up in Systems Architecture was selected along with Source Coding and Data Compression. Carleton wanted a course taught by Dr. Don Knuth on computer science, but it was unavailable until winter quarter; therefore in fall Carleton was to receive three courses: a guest lecture seminar series offered for one credit called Information Systems Seminar; a lecture course on the Management of Research Institutions offered by Dr. Hans Mark from NASA-Ames and Statistical Signal Processing taught by Stanford's Professor Gill. Only the last course entailed testing in class (Table 1).

Both schools had special classrooms available for the demonstration. At Carleton a lecture theatre, a small classroom and three rooms for individuals could be used for course reception (only the theatre could be used for transmission). The smaller rooms had 17" monitors and the theatre had 23" monitors at the front of the room as well as a 9" monitor for every two seats. Stanford's reception rooms were equipped with one small monitor and microphone for every two seats. Lecture rooms used for transmission

Table 1

CURRICULUM SHARED COURSES 1976-1977

Fall 1976

Carleton-originated courese:

Dr. Bowen: Digital Systems Architecture (292C)
* Carleton enrollment - 25
Stanford enrollment - 5

Dr. Ulug: Computer Communication Systems (also 292C)
* Carleton enrollment - 30
Stanford enrollment - 11

Classes met twice weekly for 1½ hours.

Stanford-originated courses:

Dr. Mark: Management of Research Institutions (291)
* Carleton enrollment - 20
Stanford enrollment, total 36 (classroom 14, remote TV: degree seekers 5, unregisterd 1, auditors 16)

Dr. Gill: Introduction to Statistical Signal Processing (278)
*Carleton enrollment - 6
Stanford enrollment, total 70 (classroom 35, remote TV: degree seekers 10, unregistered 9, auditors 16)

Information Systems seminar (375)
Attendance variable at both nodes

Winter 1977

Carleton-originated courses:

Dr. Ulug: Computer Communication Systems (292E)
Carleton enrollment - no information
Stanford enrollment - 2

Stanford-originated courses:

Dr. Knuth: Data Structures (144A)
Carleton enrollment - no information
Stanford enrollment, total 127 (classroom 82, remote TV: degree seekers 14, unregistered 4, auditors 27)

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* Carleton enrollment figures reported by John Daniel and Murray Richmond, in "Project Report: Educational Experiment in Canada with the Communications Technology Satellite (CTS)," in Working Document for Montreal-Stanford Telecolloquium, June 9-10, 1977, sponsored by the Institut International de la Communication.

purposes had similar monitor arrangements in addition to a monitor facing the lecturing professor. Three cameras -- typically one mounted overhead, one in the back of the room, and one in the front -- were operated remotely from a control booth in the rear of the room.

1. Course Selection

Since the course selection and implementation procedure caused some second thoughts later, it is worth examining in detail. Ken Down solicited advice from engineering faculty on courses to be selected from Carleton. Allen Peterson, Michael Sites (no longer at Stanford but a recent graduate), Thomas Kailath and Down discussed the Carleton offerings and came upon the courses listed in Table 1. Little was known about the Carleton professors, and what information Stanford people did consider came thirdhand. In other words, criteria for selection were not nearly as rigorous as those entering into a department's considerations for appointing a guest lecturer. Moreover course content was not discussed -- only titles and university catalogue course descriptions figured in the decision process. As may be expected, the sanctioning process occurred via interpersonal networks rather than formal faculty meetings and deans' approval.[26]

Ken Down talked about course format with people involved in the experiment already -- notable Allen Peterson and Michael Sites, and to a lesser extent Don George at Carleton. They decided that the Carleton courses delivered to Stanford would each have faculty proctors to follow their progress and complement the teaching process, and that students would be graded at their own schools. This decision came easily, probably reflecting what seemed at the time the most manageable route to go rather than a decision of any experimental challenge or significance (which it could have been). Professors Michael Flynn and Allen Peterson agreed to be proctors for Carleton's courses. Finally, Down arranged for some pre-course "publicity" to drum up enthusiasm for them on the part of graduate engineering students.

Hence by late August 1976 most of the planning was complete, as it should have been considering courses would begin in one month. Technical installation of requisite facilities and the delivery of equipment were nearly in order. There was still no funding for Stanford's participation in the project and no evaluation arrangements made.

2. Communication among Administrators

Total communication among the three participants can only be described as minimal. One teleconference for planning was held on August 19, 1976 between the two universities. David Coll and Don George were present for Carleton; Ken Down and Allen Peterson (and perhaps one or two others) were present for Stanford. During this session tape exchange problems (for the first two weeks of classes*) and scheduling around Thanksgiving vacation in the U.S. were the conversation subjects, although the teleconference also served to test out the system.[28] Other than the meetings described above and this teleconference, direct communication was negligible. Ames was the most heavily used link, often relaying messages between the two schools.[29] Ames may have had, on the average, one exchange per week with Ken Down during the experiment. Most of those exchanges concerned technical matters for which Ames was a logical relay. When nontechnical

*Anticipating the initial two weeks use of mailed videotapes to start the course, Stuart Paterson of Carleton's Wired City Laboratory mailed a tape to Ken Down to see how long it would take (four days).[27]

questions were at hand Carleton sent substantive queries to Down through Ames; Ken Down preferred to deal directly with the Carleton personnel and generally phoned them. All told, there was surprisingly little communication regarding actual management of the course exchange or course content. It appears that direct communication between Carleton and Stanford was particularly infrequent since Carleton preferred to communicate via Ames.[30]

It may be worthwhile to note that the entire experiment was planned and executed by an "extended family" of acquantances -- essentially an "old boy" network. Perhaps because this network operated, the levels of trust in "unknown quantities" (for example, Ken Down was not directly acquainted with Carleton people) were higher than they might have been had some other mechanism (such as formal university accreditation and faculty approval procedures) brought the parties together.

D. The Demonstration

The actual start of the experiment in October, using mailed videotapes, was disastrous for Stanford. Initial enrollment for the two Carleton-originated courses was high at Stanford; 18 students for Bowen's course, 29 students for Ulug's. However, the videotapes arrived at Stanford out of sequence and sometimes unmarked. Only four sessions of each class were taught on tapes (two weeks), but that was enough to drop enrollment in one class (Digital Machine Architechture) down to five people, and the other to eleven. One proctor reported that the students were dissatisfied with the level of the course; this may also explain that enrollment drop. Hence by the end of the second week enrollment in the experimental classes at Stanford totaled sixteen.

Problems developed immediately, mainly as a result of delayed mail. Carleton students had not gotten their textbooks for Gill's course on time; they asked Ken Down to get them. Naturally they were late. The mail proved to be much slower than was originally expected and Customs always took some time. For example, when Down sent the textbooks to Carleton they took well over two weeks to arrive in the hands of Carleton students. One course outline did not arrive at Stanford until November 2. Also, Professor Ulug relied heavily on his own notes for lecture material, which were sent to Stanford where they were copied and distributed. These invariably arrived too late for the intended lecture, causing dismay among the students.

The courses went "live" on October 18. While using the satellite was a vast improvement over videotapes by all accounts, significant problems existed. The largest ones at Stanford were dropping out of the audio talk-back capacity, and occasional picture break-up. Carleton reported problems with video and some noise problems on audio; it was also having difficulties with echo suppression.[31]

Many of these problems were not detected by anyone who could do anything about them until it was too late. Three teleconferences, one November 3, one December 16, and one January 25, 1977, served to clarify, and in a few (but not all) cases, resolve problems. Additionally, questionnaires from both Stanford and Carleton were administered to students at both ends (although the Stanford-designed questionnaires administered at Carleton never made it back to Stanford for analysis). The teleconferences and questionnaires made little or no formative impact on the experiment. However, since these resources provide the best <u>summary</u> of the demonstration's progress, I rely on them heavily for the following remarks.

Four main problem areas emerged from the demonstration, each of which is considered below.

(1) Institutional accompaniments to the system

As mentioned above, possibly the most critical failing of the system was the mail.* Videotapes, lecture notes, textbooks, and exams all went through the mail. Rarely did any arrive on time. Questionnaire results reported that late materials caused frequent problems for students.

Teaching styles had to adapt to the system. This was not a problem for Stanford professors since they had taught ITV courses previously. Carleton professors, however, felt strong pressure to adapt to the system; Professor Ulug found himself compressing lecture material and covering in one session much more than he would have in the usual live class. His format using videodisc eliminated teaching redundancies but made much more work for himself. Professor Bowen, who was teaching his first graduate class, found the medium impersonal and lamented the lack of relaxed, informal ambience that should characterize graduate classes. Both he and Ulug found the time requirements tremendous, although had they taught the same course a second time there would have been payoffs. Hence insofar as teaching may be considered an essential accompaniment to the basic system, adaptations were necessary.

In contrast, Stanford's Professor Gill did not change preparation for his course at all; Professor Knuth found it hard to have live discus-

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*Establishing a fast service facsimile might have helped. One existed between Ames and Carleton, but it was rather slow (6 minutes/page).

sions with the Canadian students and felt there was little interaction between himself and the students. But his preparation mode and time requirements were as he expected they would be.

(2) Technical quality

Questionnaires indicated that talkback capability (audio return to Carleton) frequently disappeared for Stanford students. In spite of this students reported that talkback was generally used (on a scale of one to five, the average was "2.6" with "3" being "sometimes" used), although periods of inoperability mitigated its usefulness. Students criticized camerawork in Carleton's lecture presentations, desiring more interesting visuals and more camera synchronization with the professor's points. Stanford students rated sound quality as acceptable, but a range of answers on picture quality indicated it was not entirely acceptable. Diagrams and written material sometimes suffered poor resolution due to the disc graphics, and Professor Ulug's use of videodisc caused initial problems. Carleton suffered from the noise and echo suppression problems. Also, a picture breakup problem became dominant for Canada; it seemed to be degenerative, getting worse as the system aged.

Ken Down's initial reaction to the picture format of the Carleton courses was somewhat negative. Having read the Wired City reports, he expected to see a format reflecting more experience than appeared in the first class sessions received at Stanford. For instance, Professor Bowen stood directly behind the overhead camera during his first lecture, blocking his face from view of the television students for the entire class period. Audio in Professor Ulug's first few lectures was so distorted that it was nearly indiscernable. Down noted that both audio and video improved over time.

(3) Testing, grading, and students' reactions

All final grades were awarded by each student's "home" school. Final exam grades and final grades were the responsibility of the student's own school on the grounds that this would ensure comparability within each institution's grading process (i.e., students' grades would not suffer if televised education did not "measure up" to live education). The guest lecture course transmitted to Carleton had no tests; Hans Mark's course required a term paper which, for Carleton students, was graded by David Coll at Carleton. Gill's course, however, entailed a midterm exam, a final exam, and interim homework. Gill graded only the midterm. The homework assignments would have been returned too late to Carleton students had he graded them because of the mail's time delay.

Professor Bowen's final exam was graded by Michael Flynn at Stanford; Bowen only gave out one assignment during the term, also graded by Flynn. To supplement the course Flynn gave the class additional homework, held two two-hour tutorials, and another which served as a final exam.

Professor Ulug's course recommended extensive reading and preparation. Allen Peterson proctored this course with the help of one taching assistant. Ulug had no routine homework assignments, and gave two exams and one additional math exam. Peterson graded these.

While it is difficult, if not impossible, to separate students' reactions to a professor and course content from reactions to the mode of course delivery, I found that students relied heavily on their own proctors to sort out the course material, organize it, and select the most important points. Most students made no major study adjustments to these courses and most felt the grading process was acceptable. Two-thirds indicated they would take another satellite course in the future if one sufficiently interesting was offered.

(4) Morale and enthusiasm

The early videotape experience and unexpected workloads for Ken Down, his staff and the proctors eroded enthusiasm for the project at Stanford. The proctors were overwhelmed with the time required to merely assist in the courses.

There was some individual dissatisfaction with the level of the computer architecture course and with Professor Ulug's presentations. The students who remained with the courses did not seem to lose complete enthusiasm, although they became less than excited about the demonstration experience.

Ken Down was plagued with administrative problems involving everything from textbook purchase for Carleton, to technical transmission hassles, to coping with assigning "extra" work to his staff, who felt that the experiment distracted them from work which would have had a more direct impact on the operation of the Stanford TV system.

It is hard to judge Carleton's level of enthusiasm, but it seems to have been generally higher than that of Stanford's (Odden, 1977). Their overall effort was funded, hence they possibly were able to devote more time and energy to the experiment.

Both Canadian professors were shocked at the time requirements of the system. Professor Ulug estimated that he spent twenty hours per lecture preparing videodiscs and materials to be xeroxed for students at Stanford. Bowen was somewhat annoyed with the technical bugs in the system, and disappointed about the level of rapport he had with Stanford students. Unfortunately it was only in January, after the quarter's finish, that the professors at both ends began to make suggestions about how to improve the level of interchange between students and teachers over the satellite.

E. Second Quarter

By the beginning of the second term each school decided to exchange only one course each. This in itself is some indication of the morale of respective staffs. The suggestions that could have improved the conduct of the courses came too late for any sort of test or implementation. During the second quarter Carleton received Professor Knuth's "Data Structures" course, and Stanford received the follow-up course given by Professor Ulug, with attendance in the latter staying at two people.

F. Findings and Recommendations

As noted above, three teleconferences were held to link Stanford with Carleton staff, professors and students. Two of the three were dominated by immediate concerns regarding technical problems of the system. However the last focused on administrative experiences and reactions. These, along with student questionnaires and interviews during the October to December period, form the basis for suggestions about what might have been improved. Some of these suggestions were infeasible, but many were not; had more of the problems been anticipated steps might have been taken to improve the overall performance and conduct of the demonstration.

First, Ken Down felt a strong need for more direct communication between Stanford and Carleton. In particular he desired either more teleconferences or, better still, more face-to-face contact with Carleton in the planning stages. He would have benefitted, he felt, from a tour of the Wired City facilities so that he would have had some idea of Carleton's production capabilities and format.

The professors involved had many suggestions for improving interaction with students. Professor Ulug said he and Carleton students felt the presence of Stanford students very strongly, but Professor Bowen suggested that duplex video would have made a great difference, and even suggested that constant video of the professor could be altered by occasionally reversing the video so that he could see Stanford students. Professor Knuth from Stanford also felt that eye contact was important to his teaching, and he would have preferred being able to see and hear Carleton students more than was possible in the experimental mode. Professors teaching these courses for the experiment had little or no input in project planning. They probably should have been consulted since they were in the best situation to anticipate problems with student interaction and to make suggestions to solve them. Had they been involved well before the experiment's start, more attention might have been paid to special teaching opportunities provided by the satellite -- such as varying presentational mode, soliciting student feedback, and so forth.

Stanford students seemed quite willing to cope with the technical problems presented by the system. However they had stronger negative reactions toward problems such as late materials and adequacy of the materials for their needs. They found proctors' presence helpful if not necessary, and they wanted from proctors the direction that the Carleton presentations did not seem to provide. Stanford students rated professors' presentations as adequate, but commented that more conceptual focus was needed, and that they would have appreciated more visually interesting formats (Appendix A).

Unfortunately, even under the best of circumstances, it would be hard to separate students' reactions to the system from their reactions to a specific professor and a specific course. Reactive or interactive effects of one on the others are inevitable. Hence it is hard to reliably evaluate students' reactions without some means of "controlling" variation for individual professor. Clearly, this is impossible. If we had had comparable samples for each of the two Stanford-delivered classes, it might have been evident; but with the small and unequal samples we had here (five and eleven students), this is inappropriate.

Data from Carleton students, assessed using a different questionnaire designed by Carleton (also in the appendix) are analyzed in another report; results seem to show a moderate positive reaction to the experiment from both schools' students, with no significant difference between Carleton and Stanford students on any dimension except Carleton students reacted more positively toward the overall system than did Stanford students (Odden, 1977).

Students suggested that they would have liked more homework, improved technical quality, and notes in advance of the lectures. Some thought proctors or TAs could have provided them with lecture summaries, or more readings, or felt they could have been more available for consultation. A few suggested the proctors teach the course -- in other words, eliminate the "shared" component.

In summary, the predominant feelings of students, administrators and professors seemed to be: (1) administrators wanted more interpersonal communication and contact with planners, and more lead time on such things as lecture notes; (2) professors found interactions with distant students unsatisfying, and professors unused to ITV had to adapt to television format; (3) Stanford students did not complain about their interactions with professors, but found technical problems somewhat annoying, course formats objectionable, and delays in acquiring materials bothersome.

VI. Cost Considerations

One item all communications satellite users examine these days is cost. Unfortunately, not only are experimental satellite costs a difficult base from which to generalize, but also it is hard to know exactly what to look for when assessing potential operational costs. One of the goals of the Stanford-Carleton-Ames experiment was to investigate costs, with operational systems in mind. Explicit dollar figures are impossible: Ames' costs can be estimated (predominantly the hardware component), but Stanford's are impossible since all were absorbed by the Instructional Television Network without separate funding. Carleton, on the other hand, had some funding to support special experiment personnel and expenses; perhaps their cost projections will be illustrative of a typical curriculum-sharing project's costs. One way to salvage some of the economic information from the experiment at Stanford may be to look at cost categories, items or areas which absorbed expenses — many of them rather unexpected.

Before embarking on this however, it may be well to briefly consider the ideological framework in which costs play a role. Obviously, satellite users are interested in costs in order to know if an investment is worthwhile. Two perspectives generally reign here: cost-effectiveness evaluation and cost-benefit evaluation. While even economists argue over precise definitions of the terms, for our purposes we can say that cost-effectiveness trades off costs per "unit" of result, such as level of education, improved health care, and the like; it compares inputs to outputs, calculating the cost of a system, then generally comparing that cost to one obtained under different systems or methods offering the same output (Klees, 1976). (With respect to satellite technology, a cost-effectiveness comparison is often made between satellite-delivered courseware and face-to-face teaching). Cost-benefit analysis entails the relationship between a system's outputs and general social and/or economic goals: here, frequently, goals cannot be rated against each other in dollar terms. For example, how can we evaluate the relative usefulness of a philosophy professor versus a yoga teacher? Clearly a social decision is needed, an evaluation based on the point of view of society as to which goals are most desirable. Once the benefits have been specified in terms of dollars, a ratio of costs to benefits may be evaluated, and trade-offs may be more evident. (Levin, (1975) chooses to define the two approaches by stating, "When the effectiveness of programs in achieving a particular goal (rather than their monetary values) is linked to costs, the approach is considered to be a cost-effectiveness rather than a cost-benefit analysis").

As pointed out earlier, satellite technology was recognized long ago as one means to cut education costs by spreading them across a large population; it was also seen as a solution to expanding educational (and other social service) systems to inaccessible or remote regions. But in far too many cases, enthusiasm for the medium has outdistanced cost and other considerations.

For example while Klees and Wells (1977) point out that users of advanced technology typically "hoped that new technological approaches can contribute to advances in efficiency and productivity for the education sector, similar to those that have been attributed to technology improvements in other sectors of the economy," few have unqualified praise for high technology. One critic notes that many countries newly acquiring television (for national development, status, etc.) face the problem of suddenly having a horse without a carriage -- a medium without any programming (Katz, 1973).

This is all by way of stating that an infatuation with technology may have blinded us to valid comparisons and evaluations of goals, alternative methods of achieving them, costs, and the larger scenario of capital-intensive technologies.

Cost effectiveness and benefit analysis may at least make plain decisions and priorities entering into a commitment to a technology-based education system: once consciously entered into a decision equation, costs and priorities can perhaps be most reasonably examined.

A. Costs in the Carleton-Stanford-Ames Curriculum-Sharing Demonstration

Curriculum-sharing in the United States and Canada is not new. For years we have had radio networks, extension education, and instructional television that have all operated as curriculum-sharing entities. Effectiveness and utility have been demonstrated (Schramm, 1977; Gibbons and others, 1977; Jamison and others, 1976). The key consideration in a developed country context is whether or not satellite-based curriculum-sharing can produce the same or better result (assumably learning) than other means for equivalent or lower costs.

Outputs

The "output" in the educational setting is usually learning measured objectively by tests and controlled experiments; more subjective measures obtained through interviews and participatory observation can also provide information on comparability of learning achieved in different settings. The problem with measuring outputs is that one is not always sure that outputs are directly comparable across measurement instruments. For example, critics frequently point out that while computation tests for a math course may show equivalent learning for televised and non-televised courses, there are always other kinds of learning taking place in various educational environments -- role modeling, participation skills, visual skills, and so forth -- that are not amenable to assessment through computation tests. The quintessential notion is that every teaching medium has its own "content", and that content is different for a televised course than for a nontelevised course. Such differences must be considered when evaluating outputs even though they are not easily quantifiable. In the case of a situation such as the one at hand, where highly motivated graduate level students are involved, the proper output may be measures of learning and a scale of student attitudes toward the system.

Inputs

The input side of an evaluation equation must include all costs -- time, energy, equipment, materials -- utilized in a given system. In the case at hand, since most of the "costs" were volunteered, this is impossible to total. However, we can make some estimates of experimental hardware costs and then move on more general cost categories for other expenses.

NASA-Ames purchased special equipment, and also carried development and testing costs for that equipment.* Four general items of significant cost were: the modem, which including development costs came to $55,000 (with a copy for Carleton costing only $20-25,000); a video processor which including development costs came to $65,000 (a copy for Carleton cost only $40,000); an error-correcting coder which cost $22,000 (a second coder was leased, the purchase cost of which would have been $18,000); the transmitting station cost more than $100,000, but that figure is misleading since station equipment is more sophisticated than the experiment

* These costs are approximate.

alone would warrant.** The station, it must be remembered, was designed for capabilities beyond those needed by the CTS experiment. Hence its cost is not really indicative of bare minimum costs for this demonstration.

Three people were mainly responsible for Ames' effort: Dale Lumb, Larry Hofman, and E. H. Gross, the Ames' RF engineer. First, planning and equipment development/testing required their time. In the later operational phase, management activities, coordination and operating the transmit station two hours per day consumed hours; reports, meetings, and consultation with other CTS experimenters also bit into schedules. Overall, this amounted to nearly two persons' time continuously.

The Institute for Communication Research contributed small amounts of time to the demonstration. Ed Parker estimated his time spent on the demonstration to average about four hours per month over a two year period, which went toward project planning, writing proposals, and attending coordination meetings. Heather Hudson also contributed time to project and evaluation planning. She chaired a committee reviewing the evaluation plans of all CTS social experiments and represented Stanford at CTS users meetings in this capacity. The Institute also conducted compressed video pre-tests to

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** A breakdown of station equipment costs includes:

high-powered amplifier (Klystron)	$ 16,000
power supply for Klystron	25,000
up converter	4,000
down converter	5,000
impatt diode amplifier	6,000
antenna, mount, & feed	19,000
preamplifier (for antenna)	4,500
phase lock sources (2)	8,000
oscillators (4)	4,000
audio and video switch	8,000
other test equipment	18,000 +
microwave link between Ames & Stanford	24,000

assess use acceptability (Zachon, 1976). As previously mentioned, Ames awarded Stanford an $8,000 grant to do this evaluation. The present case study, which began in November 1976 and followed the project through its duration, represents the Institute's overall evaluation of the project. It had no direct funding, except for secretarial support and supplies provided by NSF grant MCS 73 07973.

The Stanford Instructional Television Network made substantial contributions to the demonstration in terms of time spent by personnel and in terms of material costs it absorbed. The only reason it could absorb them was because of its already extensive operating system. Major components of the Instructional Television Center's instructors' participation are listed in Table 2.* All of these costs are variable depending on course enrollment and number of courses shared. We can predict that the most important incremental costs would be personnel costs (administration, professors, staff) under operational circumstances, in light of the fact Stanford's TV network currently spends 80 percent of its yearly budget on personnel for courses. We must note too that Stanford's costs for the demonstration represent the bare minimum effort and resulted in a product that may not have been acceptable under other conditions.

This project relied on the availability of already existing facilities at Stanford and Carleton whose technological groundwork merely required some alterations to link with the communication satellite. Additional costs of an operational curriculum sharing endeavor based on similar highly developed terrestrial facilities would largely be determined by the size of the curriculum sharing or distribution network.

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*These categories are based on personal observation of operations as well as previous reports on the operation of the Stanford Instructional Television network. See Jamison and others, A.I.D. Studies in Education Technology "Cost Analysis for Educational Planning and Evaluation: Methodology and Application to Instructional Technology", January 1976.

TABLE 2

Breakdown of Stanford's Inputs to the CTS Experiment

INPUTS	ALLOCATED	REQUIRED
1. Personnel		
Project administrator	Ken Down, one-fourth time in start up phase; less once routines became established.*	One half- or full-time administrator
Television staff - technicians	10 hours/week for three courses*	Same
Television staff - camera people	One per lecture; $100/course*	Same
Professors	One-fourth time, cost = $2,000 - $2,400/course*	Increased payment for more time preparing class for TV audience, generating new teaching techniques, etc.
Teaching assistants	One for Fall Quarter only, one-half @ $370/month*	One per course, depending on allocation of proctor time and responsibilities
Proctors	Two during Fall Quarter, at $800/course each*	Ten percent time per course = $800/course
Secretary	None allocated	One half-time position
2. Facilities		
Stanford Instruction Television studio facilities; Control room and apparatus	Usual broadcast cost of operational system is $35/course hour, provided gratis	Variable, depending on number of participating schools

* Provided gratis

Table 2

Breakdown of Stanford's Inputs to the CTS Experiment

INPUTS	ALLOCATED	REQUIRED
3. Materials and Equipment		
Videotape (for two weeks of lectures)	None allocated but used 10 60-minute tapes.	$12/lecture or approximately $120 total here; variable otherwise at $12/lecture
Duplicating costs for classroom materials	None allocated but used approximately $70 worth.	Variable
(Extra format requirements: slides, tapes, film rentals, etc.*)	None used or allocated	Variable
4. Other		
Mailing costs between schools	None allocated, $100 here.	Variable
Telephone costs between two sites	None allocated, cost $200.	Variable
Travel: coordinating plans, site visits, etc.	None allocated.	Variable with system size
(Auxiliary services such as high speed facsimile*)	None	Variable

*Not used in this experiment but possibly utilized in operational format.

B. Assessing Cost-Effectiveness

The critical question about costs for curriculum-sharing networks is how satellite-based distribution cost compares to that for other distribution modes -- such as cable, ITFS, closed circuit television, and mailed videotapes (for video courseware), assuming the same benefits or outputs are common to each educational setting. Cost accounting is impossible in the case at hand since (1) satellite time was free, (2) much of the equipment was newly developed specifically for this experiment and as such is not representative of operational equipment costs, (3) much of Stanford's effort was essentially donated, and (4) it is not clear that what sufficed for an experimental system would have been an adequate operational system. Had we been dealing with an operational system which did not have development costs, we would have to pay attention to important details: when compiling facilities costs, depreciation costs, and opportunity costs must be figured (the latter is especially important if one considers that ITFS facilities used for satellite curriculum-sharing could instead be used to expand course offerings in its own network vicinity); also, if facilities are used for more than one purpose, computations must reflect this.

Ultimately, what the analyst arrives at is an average cost per unit of "effectiveness" under different curriculum-sharing modes. Unfortunately, this demonstration was not designed to provide "output" measures of effectiveness (e.g. learning and attitudes). Hence, we really cannot go very far in assessing cost effectiveness. The relevant tradeoff with satellite distribution is typically the number of students reached -- at albeit high total costs but probably low per student costs. A system with high volume and already established facilities could probably pay for itself on a tuition basis. If tuition at schools such as Stanford now prices courses at about $100/unit, the average three-credit course costs a student $300. If we estimate satellite distribution costs at $500/hour*, a 30-hour (three credits over ten weeks) course would cost $15,000; this means that if at least 50 students paid to receive this course at remote locations at Stanford's tuition rate, the distribution system could conceivably pay for itself.

This assessment of costs and possible outputs is not completely satisfying. Nonetheless, it is as much information as can be provided within the demonstration's design. The sort of curriculum sharing in which Stanford participated seems as if it could be cost effective at the $15,000/course cost, provided the educational experience was of acceptable quality. The latter may be answered by future experimentation.

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* The $500/hour total figure depends on economics of scale within a distribution system, but is a figure currently in use among planners for an engineering consortium.

VI. Conclusion

One main purpose of experiments such as digital curriculum-sharing is to provide information which can contribute to future operational know-how. It is the evaluator's role to separate the meaningful information from the meaningless, and to offer an interpretation of and perspective on that information --in short, to explain failures and successes, to identify areas ripe for improvement, to suggest alternatives to the tested ideas or projects which might achieve similar ends.

The Stanford-Carleton-Ames effort does provide guidance relevant to establishing an operational system. It was a success: for six months, two universities exchanged courses on a daily basis, coordinating sending and receipt of study materials and exams. Yet, there were many elements of the planning and operation which might have been improved. While this experiment comments only on one kind of course content (graduate engineering courses) presented in one format (lecture), we can generalize from its results to a broader field of university-level curriculum-sharing endeavors from the following summary of successes, problems and possible improvements of various aspects of the system.

A. The Technical System

The audio and video quality of the system were generally quite acceptable. Occasional picture break-up marred some sessions. More serious were infrequent failures of the talkback system. At times a remote professor went through his lecture unaware of this type of problem, not realizing that distant students could not "talk" to him until the end of the lecture when he might attempt some informal conversation with them. Professor Ulug's use of videodisc encountered some resolution difficulties which were quickly remedied. In any event, the digitized video successfully transmitted coursework for the duration of the experiment.

B. Student Attitudes

The students on whom we have data were all in all neutral about their satellite education. Many, at the end of their course, said they would take another satellite-delivered course if interested in its subject. Some complained about individual professors, lengthy readings or use of the videodisc, but none of these complaints seemed sufficient to greatly discourage any of the students. By the same token however, their initial enthusiasm (as reported by tutors) dampened. The novelty of their courses wore off over time. What is most significant is simply that the students adapted to the system: they lived with its faults and capitalized on its offerings.

C. Logistics: Scheduling, Accreditation, Course Coordination, Grading

Course scheduling and accreditation never posed any problems during this experiment. Arranged through informal channels, scheduling and course approval slipped into place with little debate, although questions as to the appropriateness of some course levels were raised *post hoc*. Sending and receipt of readings and exams always encountered delays, some due to nonavailability of materials (textbooks, for example), and most often due to slow postal service.

As mentioned earlier, students received final grades from their "home" schools where their exams were graded. Grading never proved problematic for either school.

The fact that these logistical elements never caused major difficulties does not mean however that they could not be improved. The informality of such arrangements would prove troublesome if attempted on an operational scale. Even during the demonstration, it occurred to some that course and professor selection should have been subjected to more rigorous criteria, guaranteeing that needs and provided services fit well. In an operational system of any size, user satisfaction would depend on some established standards for obtaining the right course taught by the right person.

D. <u>Morale and Enthusiasm</u>

Enthusiasm for the experiment on the parts of Stanford staff and students dwindled over time for several reasons: for students, the technical problems were enough to tarnish the glitter of satellite experimentation, particularly the first weeks on videotaped lectures; they were also annoyed with having to fill out bimonthly questionnaires on their attitudes toward the experiment. Likewise, as the demonstration became routine, the Instructional Television Network's enthusiasm lessened. Fall quarter's sharing of five courses became two in Winter quarter, with Stanford enrollment in Carleton courses dropping from 16 in Fall to two students the following quarter. While this deterioration in interest can be expected with any phenomena, in the case at hand it facilitated the slowdown in Winter quarter to only one course trade per school.

Why did enthusiasm for the project slacken? Simple passing of time is one explanation. The early problems with tapes are another reason: this initial disappointment perhaps diluted later success.

Another reason has to do with the lack of financial support for Stanford's efforts in the demonstration; a project can exist on volunteer energy for only so long.

E. Costs

Absolute costs for the project are unavailable, and those that we do mention in earlier pages are misleading in that they represent heavy initial investments (e.g., for Ames' equipment) without any opportunity to retrieve costs through operational services.

The experiment provided evidence of numerous "hidden" costs of which users must be aware before embarking on similar projects. Given the need for auxiliary teaching (tutors or proctors) and other materials (reading and exams, receiving facilities, etc.) to support satellite-delivered lectures, users must critically evaluate the savings they expect to reap from plugging into satellite resource-sharing systems.

Opportunities for networking course sharing or distributing systems among schools or between schools and businesses exist now. Other (than satellite) forms of instructional technology can facilitate sharing of resources and expertise (radio networks, videotaped courses, and so forth), but ultimately satellite delivery should be able to combine cost-effectiveness with high quality instruction for large groups of users. The crucial question must be whether it is feasible for enough users to cooperate in a large course-sharing maneuver to offset costs of operational satellite curriculum-sharing. *A priori* largeness presupposes course format constraints, increased central administration (and administrative costs) as well as more logistical arrangements. Such a system also presupposes appropriate receiving and possibly audio or audio-and-video return facilities at each site. This curriculum-sharing demonstration cannot provide answers to the most critical cost questions, but at least it augments the call for further examination of costs in light of system exigencies and hard-nosed analysis of whether or not one really obtains what one pays for.

F. Course Formats

Stanford and Carleton courses employed "talking head" lectures with frequent visuals, usually diagrams. While students said they wanted and often used talkback facilities, classes by no means operated in discussion formats. Neither professors nor students were entirely satisfied by their courses, yet theirs seemed the easiest* mode and functioned adequately. Lecture and talkback would be amenable to even larger delivery designs, but it is important to realize that more students in large networks translate into less chance for two-way interaction and less chance for presentational formats amenable to small groups (teleconferences, panels, and discussions).

This experiment did not test course format variety's effect on learning and user acceptability. Quality instructional technology could benefit from more examination of the role course format can play in the educational process, and this should certainly be a priority research area in future curriculum-sharing demonstrations.

G. Planning and Communication

Years of planning preceded this experiment, but many people originally involved in designing the project were not around as the start date approached; Ken Down assumed responsibility for a demonstration in which he had had little prior input. Hence his planning, coming rather late in

*We must bear in mind that Stanford professors made little or no adaptation to satellite lecturing, but Carleton's professors expended great amounts of extra time preparing lectures, notes, and videodisc for their courses.

the project's history, had to consist of basic time-crunch deadline goals: what courses to exchange, how to publicize them, who to proctor them, and so forth. The full scope of experimental possibilities receded under time pressures on limited personnel.

Curriculum-sharing's success came more emphatically in the realm of hardware than in software. Given the first-order functional necessity of operating equipment, the allocation of funds and labor to hardware by Ames, and the tenure of the same personnel working on hardware for the duration of the experiment, this should not be surprising. Lengthy planning paid off. Software received far less planning, although it was assumed that the two schools' expertise with media (Stanford's TV Network and Carleton's Wired City) would be sufficient background to meet software requirements. And indeed, both schools were able to do so, but not without ignoring many interesting experimental opportunities. There were no extra funds for the Stanford Instructional TV system to alter its usual format, software personnel were essentially nonexistent, and this aspect of the experiment received little forethought. Hence varied presentational formats, different styles of student-teacher and student-student interaction and other-than-teaching applications of the system (counseling, informal discussion between Stanford and Carleton, department colloquia shared by two schools, etc.) were never tried.

Doubtless the major barrier to more software planning--as well as to improving most other weak spots in Stanford's conduct--was the lack of funding. The demonstration badly needed a full- or at least half-time paid administrator to deal with details such as getting materials to students on time, responding to technical breakdowns, and to plan and conduct experiments exploring software capabilities and their effects. Had funding been available, more extensive planning in line with experimental goals would have occurred. As it was, planning focused, as it had to, on operational elements--obtaining proper hardware, lining up the teaching staff, making and checking system alterations, and so forth.

Even so, had others been involved in what planning did take place, the demonstration might have been different. If interested professors,* students or other educators had been recruited or invited to give input, the project might have been more innovative. Professors might have altered their lecture mode to more strenuously solicit feedback from distant students. Students, given the opportunity to express their own ideas about what is desirable in this sort of course, might have contributed sound suggestions while maintaining their own enthusiasm for classes.

Another significant element of the demonstration's conduct entails communication among its planners and executors. As mentioned in Chapter V, Ames functioned as a communication link between the two schools for many exchanges which had nothing to do with Ames *per se*. It operated as a gatekeeper of sorts. This relay position did not enhance the rapport and sense of contact between the staffs at Carelton and Stanford. While it appears Ames' middleman role allowed it to send or receive a message via CTS during daily transmission time at no expense, the two schools might have benefited from increased direct contact.

Finally, formative evaluation could have been given more attention. Only three teleconferences among Stanford, Ames and Carleton were held

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*This blue-sky formula should, in fairness, be tempered by Ken Down's feeling that professors consent to TV teaching only if it involved no extra work or changes for them. Perhaps their planning an experimental course requires more incentives than an appeal to goodwill.

during the experiment itself, and these served as the most substantive source of feedback for all parties. However, two of these three dealt with technical concerns (hardware). Software and support system difficulties were not taken up in this forum until January, 1977. More frequent teleconferences devoted to evaluation and even discussion of the demonstration's progress were needed.

What does the Stanford-Carleton-NASA-Ames curriculum-sharing experiment mean for the larger contingent of satellite users and satellite watchers? Is it a promise for the future or just another "ho-hum" in educational technology? Our conclusion must be somewhere in between these poles. The digital video operated well, promising more efficient use of bandwidth in the future; serious scheduling and accreditation problems were avoided, students were by and large satisfied with the courses; and the project sustained satisfactory operations from October, 1976 to March, 1977.[5] Curriculum sharing proved at least in this case not to be the administrative hassle one might think. While unforeseen costs did emerge at Stanford, burdening the Instructional Television Network, it was after all part of the project's goal to uncover such expenses. On the other hand, the full potential of resource sharing was not tapped in this project. Further experimentation must focus on the interaction capabilities of this medium within an educational setting, evaluating obtainable results in light of other mechanisms offering similar "results". Hence curriculum sharing via satellite must still be phrased in terms of potential. The Stanford-Carleton-NASA-Ames effort should enter the annals as a modest project accomplishing modest goals, posing some unanswered questions for the future.

APPENDIX A: Stanford and Carleton Questionnaires

DEPARTMENT OF COMMUNICATION
STANFORD UNIVERSITY
DECEMBER, 1976

QUESTIONNAIRE FOR SATELLITE COURSES

This is your chance to give some feedback about this course. The following questions are part of an evaluation which will improve this curriculum-sharing experiment with Carleton. Your input on the practical matters of receiving "long distance" education is badly needed. Please answer each question as honestly as you can, and feel free to add any commentary you think might be helpful.

Respondent Averages

1. How did you feel about filling out questionnaires during the duration of the of the course? (Defusing question)

it was a bother (*#*%)	____	____	____ no opinion	____	____	it was no problem

2. In general, how would you rate picture quality during the satellite sessions?

							Respondent Averages
(1) high quality	0	4	4 acceptable	3	4	(5) unacceptable	3.5

3. How would you rate sound quality?

							Respondent Averages
(1) high quality	0	1	9 acceptable	2	3	(5) unacceptable	3.5

4. Did you use the talkback channel?

							Respondent Averages
(1) every session	3	2	7 sometimes	2	1	(5) never	2.7

5. How would you rate the talkback channel's adequacy for asking questions and obtaining relevant answers?

							Respondent Averages
(1) satisfactory	3	2	2 mediocre	4	4	(5) unsatisfactory	3.3

6. Rate the incidence of technical problems during satellite course delivery periods:

							Respondent Averages
(1) problems every session	3	3	5	2	2	(5) very few problems ever	2.8

7. How much did technical problems bother you?

								Respondent Averages
	(1)						(5)	
picture "glitches"	not at all	4	3	3	2	3	very much	2.8
sound dropping out	" " "	1	4	2	2	7	" "	3.9
echo	" " "	3	4	3	2	3	" "	2.9
others - please list	" " "	____	____	____	____	____	" "	

no talkback	3
low resolution	1
noise	1
bad tapes	1

8. Regarding course materials, were they: — Respondent Averages

on time ____ late 15 (If late, did this cause problems? 8 always, 5 sometimes, 1 rarely)

(1)						(5)	Respondent Averages
too voluminous	1	2	9 (adequate in amount)	2		scanty	2.8
enlightening	1	1	7 (acceptable)	4	1	confusing	3.2
very useful	1	2	7	4		not useful	3.0

9. Was your teaching assistant or proctor helpful?

(1)						(5)	
very helpful	2	4	6		2	not at all helpful	2.7

How could your TA have improved the course? Check any that apply.

offered more readings	1
summarized lectures	3
been more available	1
done more actual teaching	3
had more course input	1
other - please specify	

10. How would you rate your professor's presentations?

(1)						(5)	
clear		2	6	3	4	unclear	3.6
focused		1	6	4	4	unfocused	3.7
interesting		1	7	2	4	boring	3.7

11. Regarding the <u>format</u> of the courseware, were the visual content and camerawork:

(1)						(5)	
excellent		1	7 (satisfactory)	2	5	poor	3.7

How could the camerawork have been improved?

No videodisc	2
Different graphics	2

12. Did you have to make any special adjustments in your own study habits during this course?

(1)						(5)	
no adjustments	6	3	5	1		many adjustments	2.0

If so, what adjustments were necessary?

Respondent Averages

13. How would you rate testing and grading procedures used for this course as compared to those for other courses?

(1) more than fair			adequate			(5) inadequate	Respondent Averages
	1	1	7	1	4		3.2

If less than adequate, why?

14. Do you have any recommendations for improving this course or similar courses in the future? What are they?

More homework	1
Advance notes	2
Improve technical features	1
Better course	2

15. Would you take another satellite-delivered course? Yes 11 No 4

Why or why not?

16. If you would consent to a short (15 minute) interview in the future about your experiences in this course, please leave your name and phone number below.

THANK YOU VERY MUCH FOR YOUR COOPERATION!!!

Communications Technology Satellite

Curriculum Sharing Experiment

between

Carleton University, Ottawa, Ontario

Stanford University, Palo Alto, California

USER IMPACT QUESTIONNAIRE

The purpose of this questionnaire is to assess student attitudes towards the use of educational technology in this course. The following scales are designed to assess feelings and thoughts about this medium in the classroom. Even if some of them seem strange or inappropriate, it is very important that you complete them all. Work rapidly through the scales, without pausing more than a few seconds on each one, and without returning to one you have already completed. Place an X at the point on the scale which you consider most appropriate, for example...

good ___:___: X :___:___:___:___ bad

Student Number ________________

or Name ________________

BIPOLAR ADJECTIVE CHECKLIST

You are asked to assess the effectiveness of the use of educational technology in this course specifically. Please place an X on the scale to correspond to your feeling about this communication system. Do you find the experience:

relaxed	___:___:___:___:___:___:___	uneasy
closed	___:___:___:___:___:___:___	open
public	___:___:___:___:___:___:___	private
free	___:___:___:___:___:___:___	constrained
intimate	___:___:___:___:___:___:___	remote
rough	___:___:___:___:___:___:___	smooth
slow	___:___:___:___:___:___:___	fast
cooperative	___:___:___:___:___:___:___	competitive
pleasant	___:___:___:___:___:___:___	unpleasant
unsatisfactory	___:___:___:___:___:___:___	satisfactory
agreeable	___:___:___:___:___:___:___	disagreeable
cold	___:___:___:___:___:___:___	warm
meaningful	___:___:___:___:___:___:___	meaningless
passive	___:___:___:___:___:___:___	active
secure	___:___:___:___:___:___:___	insecure
personal	___:___:___:___:___:___:___	impersonal
easy	___:___:___:___:___:___:___	difficult
hazy	___:___:___:___:___:___:___	clear
foolish	___:___:___:___:___:___:___	wise
informative	___:___:___:___:___:___:___	uninformative
successful	___:___:___:___:___:___:___	unsuccessful
untrustworthy	___:___:___:___:___:___:___	trustworthy
informal	___:___:___:___:___:___:___	formal
friendly	___:___:___:___:___:___:___	unfriendly
insensitive	___:___:___:___:___:___:___	sensitive
sociable	___:___:___:___:___:___:___	unsociable
boring	___:___:___:___:___:___:___	interesting
comfortable	___:___:___:___:___:___:___	uncomfortable
emotional	___:___:___:___:___:___:___	unemotional
confusing	___:___:___:___:___:___:___	understandable
good	___:___:___:___:___:___:___	bad
unfair	___:___:___:___:___:___:___	fair
complicated	___:___:___:___:___:___:___	simple
inspiring	___:___:___:___:___:___:___	uninspiring
unreliable	___:___:___:___:___:___:___	reliable

Do you feel that this use of educational technology alters the learning ing process by:

IMPROVING COMMUNICATION OF INFORMATION

not at all ___:___:___:___:___:___:___ a great deal

INTRODUCING ADDITIONAL VIEWPOINTS FROM OTHER "EXPERTS"

not at all ___:___:___:___:___:___:___ a great deal

MEETING INDIVIDUAL NEEDS OF STUDENTS

not at all ___:___:___:___:___:___:___ a great deal

INCREASING EFFICIENT USE OF CLASSTIME

not at all ___:___:___:___:___:___:___ a great deal

HOLDING STUDENTS' ATTENTION

not at all ___:___:___:___:___:___:___ a great deal

FACILITATING LEARNING

not at all ___:___:___:___:___:___:___ a great deal

PROVIDING GREATER INFORMATION RESOURCES

not at all ___:___:___:___:___:___:___ a great deal

DIMINISHING THE IMPORTANCE OF THE INSTRUCTOR

not at all ___:___:___:___:___:___:___ a great deal

IMPROVING THE QUALITY OF LECTURES

not at all ___:___:___:___:___:___:___ a great deal

Television as an educational aid is useful to assist:

The Student to learn	Both ___:___:___:___:___:___:___ Equally	The Instructor to teach

The physical presence of educational technology in the classroom is a distraction:

not at all ___:___:___:___:___:___:___ a great deal

Do you feel that more research should be conducted before introducing this form of educational technology for widespread use in the university?

not at all ___:___:___:___:___:___:___ a great deal

Please include general comments or elaborations on your impressions of this use of educational technology.

APPENDIX B: Sample Agenda from One Stanford-Carleton Teleconference

PROPOSED AGENDA

CTS TELECONFERENCE
JANUARY 25, 1977

I. Administrative Procedures

A. Course and professor selection
B. Videotapes and printed material use
C. Organizational communication problems/successes

II. Work Load

A. Time considerations for professors, proctors, students, administrators, others
B. Recommendations for alterations in time requirements

III. Alternatives to the satellite system

A. Videotapes; audio plus printed materials; others
B. Use of talkback
C. Gains and losses using CTS versus live presentations

IV. Technical Quality

A. Sound; visual presentations; use of video discs; readability of printed materials
B. Other technical features

V. Subjective Factors

A. Acceptability of the system as a whole
B. Why dramatic drops in attendance?
C. How did the satellite system affect the "usual" features of a college course - re: student-teacher feedback, testing and grading, integration of course material with lectures, asking questions, etc.

WHAT DID WE GAIN FROM THE FIRST QUARTER EXPERIENCE?

NOTES

1. In 1964, the project title "Advanced Technology Satellite" was changed to "Applications Technology Satellite". These second generation satellites (advancing synchronous satellite state-of-the-art) began with strictly technical objectives; experiments with multiple access, new antenna technology, and frequency utilization improvements indicated new applications possibilities so that by 1970 user groups began "social" applications demonstrations. Project Approval document, March 10, 1964, NASA Historical Archives, Washington, D.C.

2. The National Aeronautics and Space Act of 1958, Public Law 85-568, 85th Congress, 72 Stat. 426, Section 103 (1).

3. Hearings. "NASA's Proposed Operating Plan for FY 1968," Senate Committee on Aeronautical and Space Sciences. November 8, 1967.

4. The 1969 budget request for NASA was $4.37 billion, the lowest amount since 1963 for the agency.

5. A phase-down decision in communication applications was adopted informally in January, 1973. NASA Internal Memorandum, NASA Office of Applications, Jan. 8, 1973 (in the author's possession).

6. Silberman, C.E., "The Little Bird That Casts a Big Shadow," Fortune, Feb., 1967, pp. 111, 223.

7. Memorandum of Understanding Between the United States National Aeronautics and Space Administration and the Canadian Department of Communication. Signed by George M. Low for NASA and Allan Gotlieb for DOC, April 20, 1971. United States State Department, Treaties and Other International Acts Series (TIAS), 7131. Franklin and Davison, 1972.

8. Experiment summaries are provided in minutes of NASA Users Meetings held from 1974 through 1977, available from the Office of Applications, NASA Headquarters, Washington, D.C.

9. Interview with Professor Edwin Parker, Stanford University, February, 1977.

10. Excerpt from an early proposal for the Curriculum-Sharing Experiment using CTS, circa 1974.

11. Interview with Dr. Dale Lumb, NASA-Ames, California, November 11, 1976.

12. Ibid.

13. Proposal for a Digital Video College Curriculum Sharing Experiment, November 22, 1972 from John Foster, Director of Development, NASA-Ames, to Dr. Richard Marsten, NASA-Headquarters, Washington, D.C.

14. Correspondence, Dr. Peterson, Stanford University, to John Foster, NASA-Ames, September 13, 1972.

15. NASA Memo Change 52, NHB 8030.1A, September 15, 1972 (announcement of experiment opportunities on the Communication Technology Satellite).

16. Correspondence, Drs. Peterson and Edwin Parker to John Foster, Director of Development, NASA-Ames, November 20, 1972.

17. Proposal for a CTS Digital Video College Curriculum Sharing Experiment, November, 1972, by Stanford University, Carleton University and NASA-Ames Research Center. Submitted to NASA-HQ by John Foster, NASA-Ames, November 22, 1972.

18. Correspondence, Dr. R. Marsten, NASA-HQ, to Dr. Allen Peterson, Stanford University, June 11, 1973.

19. Interview with Larry Hofman, NASA-Ames, California, November 11, 1976.

20. Correspondence, Dr. Dale Lumb, NASA-Ames, to Dr. Richard Marsten, NASA-HQ, Washington, D.C., September 17, 1973.

21. Ibid.

22. Interview with Professor Edwin Parker, Stanford University, February, 1977. Correspondence, Ken Down, Stanford Instructional Television Network, to Arthur Melmud, National Institution for Education, Washington, D.C., April 15, 1976. Correspondence, Professor Edwin Parker, Stanford University to Allen Shinn, National Science Foundation, January 6, 1975.

23. Interview with Professor Edwin Parker, Stanford University, February, 1977.

24. Ken Down worked individually on this, without the help of the CTS Working Group organized by and for CTS users to share technical expertise, to make group equipment purchases and go through bureaucratic processes _en masse_, and to share ideas.

25. Correspondence, Dr. Lumb, NASA-Ames, California, to Wasyl Lew, NASA-HQ, Washington, D.C., May 27, 1976.

26. Interview with Professor Allen Peterson, Stanford University, October 22, 1976; interview with Ken Down, Stanford Instructional Television Network, October 15, 1976.

27. Correspondence, Stuart Paterson, Wired City Laboratory, Carleton University, to Ken Down, Stanford Instructional Television Network, September 16, 1976. The tape was mailed 9/16/76 and received 9/20/76.

28. Memorandum on teleconference with Carleton, Ken Down, Stanford Instructional Television Network, August 19, 1976.

29. Interview with Dr. Lumb and Larry Hofman, NASA-Ames, California,

November 11, 1976; interview with Ken Down, Stanford Instructional Television Network, October 15, 1976.

30. Interviews with Dr. Lumb, Larry Hofman, and Ken Down, Ibid.

31. Teleconference, November 3, 1976 and January 25, 1977 between Stanford University and Carleton University, with Ames personnel present at Stanford.

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