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ABSTRACT

An examination is made of the potential role of communications media and technology in the future of higher education in the United States (U.S.). The status of U.S. higher education is reviewed, important trends are identified, and the rationale for increased technological utilization is discussed. This is followed by a description of selected examples and uses of large-scale electronic technology in American higher education and by a review of experiments and demonstrations involving television and computer and information networks. Particular attention is also devoted to experiments and future developments involving communications satellites. Projects in the Pacific area and Alaska, as well as forthcoming experiments in the Rocky Mountain states and in Appalachia, are described, with emphasis upon developments which might aid in resource sharing and in expanding access to higher education. The paper concludes with some brief comments concerning forecasts of the future utilization of technology in higher education and some suggestions concerning the role of communications media in the proposed World University. (Author)

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COMMUNICATIONS TECHNOLOGY IN THE FUTURE OF HIGHER EDUCATION IN THE UNITED STATES

BY

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Report Submitted To The
INTERNATIONAL SYMPOSIUM ON COMMUNICATION MEDIA
AND THE FUTURE OF HIGHER EDUCATION,
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I. INTRODUCTION

This paper will focus upon the potential role of communications media and technology in the future of higher education in the United States. First, the status of U.S. higher education is reviewed and important trends identified. The rationale for increased technology utilization is discussed. This is followed by a description of selected examples and uses of large-scale electronic technology in U.S. higher education. Experiments and demonstrations involving television, and computer and information networks are described.

Particular attention is then devoted to experiments and future developments involving communications satellites, a subject which has been the topic of study within the Communications Group of our Center for Development Technology since 1969. Experiments in the Pacific area and Alaska, as well as forthcoming experiments in the Rocky Mountain States and Appalachia are described, with emphasis on developments which might aid in resource sharing and expanding access to higher education. The paper concludes with brief comments concerning forecasts of future utilization of technology in higher education and some suggestions concerning the role of communications media in the proposed World University.

II. HIGHER EDUCATION IN THE U.S.: STATUS, TRENDS AND PROSPECTS FOR LARGE-SCALE ELECTRONIC DELIVERY

A. Current Status and Trends

Table 1 summarizes some statistics concerning higher education in the U.S. Among the most significant trends* accompanying the statistics are the following:

1) Continued Increase in Enrollments Through the 1970's

Although trends in birth rate have tended to stabilize elementary and secondary enrollments, higher education degree-credit enrollments should continue to grow throughout the 1970's although at a somewhat slower rate than in the 1960's.(1) Part of this increase may be attributable to the fact that 1) the high school graduation rate has increased from 69.3% of 18 year olds in 1961-1962 to 75.9% of 18 year olds in 1971-1972 (projected at 85.7% by 1981-1982)(1) and 2) proportionately more people are earning college degrees. Whereas in 1961-1962, 16.7% of the graduation age population earned bachelor's degrees, by 1971-1972 this figure had risen to 24.5% (projected at 29.5% by 1981-1982).(1)

By Fall 1981, it is projected that total enrollments in degree credit programs at all institutions will rise to 11.108 million from the 1971 level of 8.116 million. This represents a 37% increase, compared with a somewhat greater increase from 3.9 million to 8.1 million from 1961 to 1971. When contrasted with the predicted 10.6% increase in the total population of those aged 18 to 21 from 1971 to 1981, the figures indicate that many individuals will pursue degrees and credits who are not in the 18-21 age bracket.** Of the total of

*Most of the analysis concerning trends is based upon information in, "Projections of Educational Statistics to 1981-1982: 1972 Edition."(1)

**First-time degree-credit enrollment actually declined from 1970 to 1971 but is expected to increase 28% from 1.8 million in 1971 to 2.3 million in 1981.

Table 1: Statistics on Higher Education, Fall, 1972*

Total Number of Students Estimated to be Enrolled in Degree-Credit Programs** in Universities, Colleges, Professional Schools, Teachers Colleges, and Junior Colleges,

in Fall, 1972:	TOTAL	8.22 million
	PUBLIC	6.12 million
	NON-PUBLIC***	2.10 million
	UNDERGRADUATE	7.29 million
	GRADUATE	0.93 million
in Fall, 1969:	PUBLIC	5.11 million
	NON-PUBLIC	2.02 million
in 1949-1950:	PUBLIC	1.35 million
	NON-PUBLIC	1.30 million
in 1929-1930:	PUBLIC	0.533 million
	NON-PUBLIC	0.568 million

Percent of Population Between 18 and 24 years old enrolled:

in year 1950	14.2%
in year 1960	22.2%
in year 1971	31.6%

Number of Full-Time and Part-Time Resident Instructional Staff:

in Fall, 1972	TOTAL	620,000
	PUBLIC	415,000
	NON-PUBLIC	205,000
in Fall, 1971	TOTAL	603,000
	PUBLIC	399,000
	NON-PUBLIC	204,000
in Fall, 1961 (1)	TOTAL	292,000

Estimated Expenditures: In Billions of Dollars

in 1972-1973	TOTAL	32.5
	PUBLIC	21.8
	NON-PUBLIC	10.7
in 1971-1972	TOTAL	29.9
	PUBLIC	19.9
	NON-PUBLIC	10.0
in 1961-1962	TOTAL	8.5
	PUBLIC	4.7
	NON-PUBLIC	3.8

Median Salary for Instructional Staff at 4-year Colleges and Universities:

in 1971-1972	$12,932
in 1961-1962	$ 7,486

Tuition and Fees, and Room and Board Rates, All Institutions:

in 1963-1964	PUBLIC	$234
	NON-PUBLIC	$1,012
in 1968-1969	PUBLIC	$295
	NON-PUBLIC	$1,383
in 1973-1974	PUBLIC	$412
	NON-PUBLIC	$2,044

Current Fund Expenditures in Billions of Dollars, by Purpose, 1969-70

Total	21.0		
Educational and general		15.8	
General Administration and General Expense			2.63
Instruction and Departmental Research			6.88
Extension and Public Services			.52
Libraries			.65
Plant Operation and Maintenance			1.54
Sponsored Activities Other than Research			.77
Sponsored Research			1.84
Other Separately Budgeted Research			.30
Related Organized Activities			.65
Auxiliary Enterprises		2.77	
Student-Aid Grants		.98	
Major Public Service Programs		1.50	

Number of 2-year Institutions and Enrollments:

	Number of Institutions		Enrollments	
in year 1947	TOTAL	480	TOTAL	222,045
	PUBLIC	250	PUBLIC	163,005
	NON-PUBLIC	230	NON-PUBLIC	59,040
in year 1969	TOTAL	813	TOTAL	1,528,429
	PUBLIC	577	PUBLIC	1,412,610
	NON-PUBLIC	236	NON-PUBLIC	115,819

Source of Funds Expended for Higher Education:

In 1967-1968

	$ Billion	%
FEDERAL	3.8	19.1
STATE	4.7	23.6
LOCAL	0.6	3.0
ALL OTHER	10.8	54.3
TOTAL	19.9	100.0%
TOTAL PUBLIC	12.3	
TOTAL NON-PUBLIC	7.6	

In 1972-1973

	$ Billion	%
FEDERAL	5.1	15.7
STATE	8.6	26.5
LOCAL	1.3	4.0
ALL OTHER	17.5	53.8
TOTAL	32.5	100.0%
TOTAL PUBLIC	21.8	
TOTAL NON-PUBLIC	10.7	

*Except as noted, estimates from National Center for Educational Statistics.(3)

**Excludes undergraduate students in occupational programs not ordinarily creditable towards a bachelors degree. In Fall, 1971 there were approximately 0.833 million such students.

***Designates control of institution.

11.108 million, 8.110 million will be in 4-year institutions and a growing percentage, 2.998 million, will be in 2-year institutions.

In a recent downward revision of projected enrollments, the Carnegie Commission on Higher Education now predicts a total higher education enrollment of 11.5 million for the year 1980, a decrease to 10.6 million for 1990 and then an increase to 13.2 million for the year 2000.(2) The National Center for Educational Statistics is also reported to be revising its enrollment projections downward.(2)

2) <u>More Rapid Growth in Enrollment in 2-Year Institutions than in 4-Year Institutions</u>

In 1961, 13.4% of all degree credit students were in 2-year institutions. By 1971, this percentage had risen to 21.3% and a projection indicates a figure of 27.0% by 1981.(1) However, in terms of absolute numbers of additional degree credit enrollments projected between 1971 and 1981, some 1.7 million places must be found in 4-year institutions compared with 1.2 million places in 2-year institutions.(1)

3) <u>Growth in Non-Degree-Credit Enrollment</u>

There has been a large increase in non-degree-credit enrollments, almost all of it coming in two year institutions. The estimates, which are stated to be somewhat difficult to arrive at, show an increase from 186,000 in 1961 to 833,000 in 1971, with the largest increase coming from 1970-1971. The projected enrollment for 1981 is 1,424,000.(1) It should be pointed out that non-degree-credit courses are usually occupational or general studies program courses.

4) <u>Increase in Costs of Educating College Students</u>

In 1961-1962, the current expenditures (in 1971-1972 dollars) for all institutions averaged out to $1,676 per full-time equivalent student for student education. Expenditures at privately controlled institutions were only slightly larger than at publicly controlled institutions. For the former, by

1971-1972, expenditures had risen to $2,367 and the projected figure for 1981-1982 is $3,040. By 1981-1982, it is expected that private expenditures will exceed public expenditures by over $1,100 per student.

5) Increase in Relative Importance of Publicly Controlled Institutions

Approximately three-fourths of all enrollments in Fall, 1972 were in publicly supported institutions compared with 50% in 1949-1950. Practically no change (3% increase) is projected in private institution enrollment from 1971-1981 compared with a 49% increase in public institution enrollments. Expenditures by non-public institutions are projected to rise about 34% to accommodate the 3% increase whereas public expenditures are projected to increase by 62.5% in constant 1971-1972 dollars. Much of this increase will be attributable to increased staffing in public institutions and increased salaries for instructional staff, although expenditures for instruction and departmental research accounted for only 32.7% of all expenditures in 1969-1970. The percentage contribution of the federal government to higher education decreased from 19.1% of funds expended in 1967-1968 to 15.7% in 1972-1973.

6) Increased Educational Achievement

More people than ever before are earning college degrees at all levels, including first professional, masters, doctors, etc., and this trend is projected to continue.* The proportion of bachelor's degrees awarded to women is increasing.

B. Current Issues

1) Access

Increased enrollments could reflect a movement to make higher education almost universal in the United States.

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*From 1963 to 1973, U.S. federal spending on vocational-technical and continuing education increased 21-fold.(3) This spending may or may not have contributed to slowing down the rate of increase of college enrollments.

However, as it is now structured, higher education is too costly for many. The majority of college students come from middle- and upper-income families. Low socio-economic status has been a barrier to college entrance.[4]

In a 1970 study by Warren W. Willingham,[5] ratings for the "accessibility" of each college in the U.S. were developed. In general, a college was called "free-access" if one-third of its freshman class was admitted from the bottom one-half of their high school class and the tuition and fees amounted to $400 or less. On this basis, 789 free-access colleges were identified. Only 42% of the U.S. population lives within commuting distance of these colleges. Willingham's analysis indicates that some 375 additional colleges in optimal locations would be required to put roughly two-thirds of the population of most states near an accessible institution. He states that because colleges can not be expected to be located optimally, the 550 new colleges recommended by the Carnegie Commission* would raise the proportion of the U.S population covered from about 4 in 10 to about 7 in 10.[5]

Increased access has been fostered by the rise of the community or junior college, probably the most important U.S. educational innovation since the land-grant college. Because of their relative newness and lack of tradition compared with four-year colleges, some feel that community colleges are fertile ground for technological innovation.

Increased access can be fostered by a variety of mechanisms. The Open Admissions policy of the City University of New York is one. The "Open University" approach in which learning can take place at home with the aid of telecommunications is another as are the growing number of "external degree" programs.

2) <u>Equality of Educational Opportunity</u>

Racial minority groups have been severely under-represented in the U.S. system of higher education. Although

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*The numbers of colleges required may be reduced somewhat in view of the recent downward revision in predicted enrollments by the Carnegie Commission.

the number of Black students enrolled in institutions of higher education more than doubled from 1964 to 1970,[4] the percentage of Blacks in college still lags behind the percentage of college age students represented by Blacks. The situation is even less satisfactory in graduate and professional education.

Women also experience difficulties in the U.S. system of higher education. Enrollment rates (as a percentage of the relevant age group) are distinctly lower than for men. In addition, "there is evidence of discrimination against women in admission to institutions of higher education, especially at the graduate and professional levels, and there is a good deal of discrimination against women on college and university faculties."[4]

3) Financing Higher Education

Higher education represents the formal educational sector in which expenditures are growing most rapidly. It is more expensive on a per pupil basis than elementary or secondary education. Increasingly, higher education is becoming predominantly a public sector activity, with some 75% of students enrolled in publicly controlled institutions. State legislatures provide substantial inputs to college revenue receipts. So does student tuition.

The financial crunch is perhaps most severe on private institutions, which in effect have stabilized their enrollments. Many are underattended compared with the space they have available. Rising tuition costs have made it increasingly difficult for all but the relatively wealthy to attend non-public institutions, thereby tending to stratify the higher educational system and to threaten, to some extent, its diversity.

Although increased federal spending in higher education is anticipated by some, the federal share of support for higher education has actually decreased in the past few years.

4) Issues Concerning Students

A variety of student concerns include: 1) inadequate variety of courses available, 2) lack of quality in some classroom instruction,[6] 3) too much emphasis on academic subjects at the expense of relevance to life, 4) not enough variety in the educational process, 5) too much lockstep education preventing relatively easy entry and exit, etc. A major theme which emerges here is the need for more variety, more diversity, more student-initiated activity. Some new innovations in higher education such as the "University Without Walls," attempt to respond to these issues.

5) Other Issues

The Carnegie Commission on Higher Education has issued an extensive series of reports analyzing issues in higher education. These reports provide a wealth of material on key issues confronting higher education. In March 1971, a Report on Higher Education (the "Newman" Report) was issued which was funded by the Ford Foundation.(7) This report also recommends a variety of actions to meet changing needs in higher education. Among the issues identified by the Newman report include 1) the need to let individuals other than those of "college age" have access to higher education and 2) the need to find new ways to go to college to combat the growing homogenization, bureaucratization, and professionalization of learning. The Carnegie studies and the Newman study both see technology as having a role in bringing about the changes they recommend.

C. Technology in Higher Education: Rationale

1) Productivity and Efficiency in Education

An issue of concern to planners, policymakers, college board members and administrators, and parents is that of how to keep educational costs within reasonable bounds. The National Academy of Engineering recently addressed this issue in a report of its "Workshop on Application of Technology to Improve Productivity in the Service Sector of the National Economy."(8) A major study on the subject of "Productivity and Efficiency in Education" has also been undertaken by a panel of the Federal Council on Science and Technology.(9)

Estimates of percentages vary but it is true that education is probably the most labor intensive of all major sectors. Thus, for some, education looms as a frontier for applying those techniques, concepts and technologies which have worked in other "industries". Supporting this argument is the fact that per pupil expenditures are rising faster than would be explained by inflation, indicating that the increased costs for education over the last few years have not been totally attributable to increasing enrollments.(10)

Although economic pressures on private, "elite" universities would seem to favor increased technology utilization, these universities tend to be tradition-bound and more geared towards smaller classes and extensive student-teacher contact. Large state universities have used television to extend classroom instruction in basic courses to large numbers of students. These latter universities and community colleges are now the major focus of attention for large-scale educational technology demonstrations. Extensive involvement with computers for research and administration is a reality and regional computing networks are coming into being. A number of surveys and forecasts predict extensive utilization of technology for instruction within the next ten to twenty years, particularly in more non-traditional forms of higher education.

If such increased utilization is to become a reality, some very real issues will have to be faced. New incentives will have to be provided for faculty members to develop quality courseware. Currently, the "publish or perish" syndrome limits such faculty participation. In some large universities and community colleges, collective bargaining and unionization are beginning to take hold which may limit the extent to which technology can replace rather than substitute for teachers. Finally, it should be recognized that the technology itself may have some real limitations. For example, John Kemeny, who pioneered in the development of time-shared computing at Dartmouth, has questioned the extent to which computer-assisted instruction may be appropriate as a replacement for a book or a teacher.[11] Others may not share this view but the need for proceeding with caution to ensure that the technology is not misused in the concern over productivity and economy is clearly in order.

2) Diversity and Access

There is currently a growing movement in the U.S. towards more diversity and towards non-traditional forms of higher education. The rationale for this movement and examples of activity are contained in the recent Report of the Commission on Non-Traditional Study, entitled Diversity by Design.[12] The major recommendations of this report include:

"1. Lifetime learning--basic, continuing and recurrent--has a new appropriateness today and requires a new pattern of support.

2. Colleges and universities must shift emphasis from degree-granting to service to the learner, thus countering what has become a degree-granting obsession.

3. Faculty understandings and commitments must be reoriented and redirected, particularly through in-service development, so that knowledge and use of non-traditional forms and materials will increase.

4. An organized effort must be made to promote intelligent and widespread use of educational technology with special emphasis on programming for cable television, computers, videotape recorders, and possibilities of satellite broadcasting.

5. New agencies must be created to make possible easy access to information and develop better ways to disseminate it, to perform guidance and counseling services, and to be assessors and repositories of credit for student achievement.

6. New evaluative tools must be developed to match the non-traditional arrangements now evolving, so that accreditation and credentialing will have appropriate measures of quality.

7. Cooperation and collaboration must be encouraged among collegiate, community, and alternate educational entities so that diverse educational programs and structures may come into being."[12]

Technology can aid in fostering this diversity. It can do this by enabling students to have access to learning resources that are not necessarily at the same location as the student. It can aid in the formation of new kinds of institutions that are not geographically bound. The scarcity of "free-access" colleges cited by Willingham(5) and the imposing numbers of new institutions called for by the Carnegie Commission(4) may be strongly affected by the extent to which communications technology can make inroads into higher education. Here the British experience with the Open University and other such experiences are particularly relevant.(13) Although TV and radio broadcasts may occupy a relatively small percentage (say 10-20%) of the student's learning time, they represent an integral element of the "outreach" aspect of the Open University which begins to weaken some of the geographical restrictions previously imposed on higher education.

The issue of access is also related to productivity or economy in higher education. Bowen(14) has roughly estimated a cost per student of $1,675 for non-traditional U.S. higher education structured with some telecommunications component. This is less than the average cost per student in public colleges and universities of about $2,127 and about $2,731 in private universities.

3) <u>Resource Sharing</u>

Smaller institutions which cannot now afford or who do not have access to certain people, course subjects, library materials, and computer time and programs may be able to share resources with other institutions by using telecommunications. Regional libraries, computing networks, and TV networks are in operation which do provide some of these services to a limited number of institutions on a limited basis. It might even be possible to provide the kind of peer matching and skills matching of individuals that Illich(15) talks about via computer-communications links. However, the latter seems a much less probable development than resource sharing within an institutional framework.

III. LARGE-SCALE ELECTRONIC TECHNOLOGY: SELECTED USES IN HIGHER EDUCATION

A. Television

Television has been used in higher education for more than 15 years and in a variety of ways. Early efforts include the "Continental Classroom" broadcasts carried on commercial networks during early morning hours, closed circuit TV used for teaching large enrollment courses in large state universities, and the "TV college" idea as implemented by Chicago TV College since 1956.

Recently, television has been receiving increased attention as a result of the success of the Open University in Great Britain. Four U.S. universities are experimenting with Open University materials. A number of states in the U.S. are in the process of planning or implementing "open" or "external degree" programs at the state level. A group of community colleges and other institutions which have been actively using television are beginning to consider the possibility of joining forces via a telecommunications interconnection and by developing cooperative software or courseware projects.

A particularly active area has been that of television for continuing professional education. Project Surge at Colorado State University has made extensive use of videotapes to offer engineering courses at industrial, off-campus locations.(16) Stanford University uses "talkback" television to reach industrial locations via ITFS.(17) Several large state universities serve regional campuses and off-campus locations via intrastate instructional television networks(18) and the list appears to be growing.

B. Computers

Computer use in education has grown extensively in the U.S. over the last ten to fifteen years. In higher education, computers are utilized for research, instruction and administration. In 1966-67, the percentages for these three functions were 40%, 30% and 28% respectively. Various applications of computers in education are shown in Figure 1.

Larger schools and those granting higher degrees have greater access to computing facilities than smaller schools and those that do not grant advanced degrees. In 1967, the President's Science Advisory Committee (PSAC) recommended some 20 minutes of computer time per student per year as a goal for computer usage in higher education. However, about one-half of the nation's colleges and universities were estimated to be entirely without computer services as the 1970's began.[18]

Much computer instruction in higher education is about computers rather than with computers. However, efforts to develop computer-based instruction systems for use in higher education are underway. The U.S. National Science Foundation is currently funding two major CAI demonstrations; one using the large and highly centralized Plato-IV system (Programmed Logic for Automatic Teaching Operations) developed by the University of Illinois, the other the TICCIT (Time-Shared, Interactive, Computer-Controlled Information Television) system developed by the MITRE Corporation.

Plato-IV is designed to serve ultimately 4,000 specially designed terminals with a plasma display panel and with memory provided by a centrally located single large computer. It is projected that such a system would cost $0.34 per student contact hour if costs are amortized over 5 years and it is assumed that the system is used 8 hours a day for 300 days a year.[19] Currently, there are 230 terminals connected to a central computer at Urbana. The Plato approach has stressed teacher involvement in preparation of courses and many professors and students at the University of Illinois have used

	Instructional Applications of Computers					Administrative Applications of Computers				Research Applications of Computers								Library Applications		
	Instruction about Computers			Instruction with Computers						Research on Computers			Research with Computers							
	Specialist Instruction	Service Instruction	Survey Instruction	Computer Assisted Instruction/ Computer Based Instruction/ Computer Managed Instruction	Computer Assisted Problem Solving	Computerized Financial Operations	Computerized Personnel Management	Computerized Program Management	Computerized Facility Management	Hardware Oriented Research	Software Oriented Research	Research on Theory and Science of Computing	Number Processing	Symbol Processing	Data Processing	Event Processing	Picture and Sound Processing	Circulation Automation and Computer Aided Cataloguing	Computerized Indexing and Retrieval	Computer Aided Vocational Guidance
Elementary Schools				X		X	X	X	X						X					
Secondary Schools			X	X	X	X	X	X	X						X					X
School District						X	X	X	X						X			X		
Vocational Schools	X		X	X		X	X	X	X						X					
Community Colleges	X	X	X	X	X	X	X	X	X						X					X
Colleges	X	X	X	X	X	X	X	X	X		X	X	X	X	X	X		X	X	
Universities	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	

Figure 1: Computer Applications in Education*

*from Ref. (39)

the facility. Terminals are being installed in junior colleges in the Chicago area and courseware is being developed for several basic junior college courses spanning a variety of topics.

In contrast to the large computer utility approach of Plato-IV, the TICCIT system is more analogous to a minicomputer. TICCIT connects a small computer to home television sets via coaxial cable, using the TV set as a display device, a "frame-grabber" for displaying still pictures, and a response pad for student interaction.[20] Hardware costs for a system with 128 terminals is estimated at $450,000 currently with somewhat lower costs ($300,000 to $400,000) expected if the system is widely used. In contrast to the Plato-IV approach, an attempt is being made from the outset to develop courseware which could be used widely in beginning algebra and math courses at the community college level. Courseware is being developed at Brigham Young University and will be used at Northern Virginia Community College and Phoenix Community College.

Cost projections for both Plato-IV and TICCIT indicate that operational systems will provide instruction at less than the costs of traditionally-administered (teacher) instruction. Should these projections be realized, these systems may have a substantial affect on the future of higher education in the U.S.

C. Computer and Information Networks

During the period from 1968-1972, the U.S. National Science Foundation funded the establishment of some twenty-five experimental regional computer networks. Figure 2 pinpoints the approximate location of these networks. The advantages of participating in such a network cited by Weingarten et al.[21] are: 1) the efficiency and variety of computer services and 2) the economy of sharing such a system. Generally such a network ties a number of smaller institutions to a larger institution. For example, Dartmouth College, a pioneer in

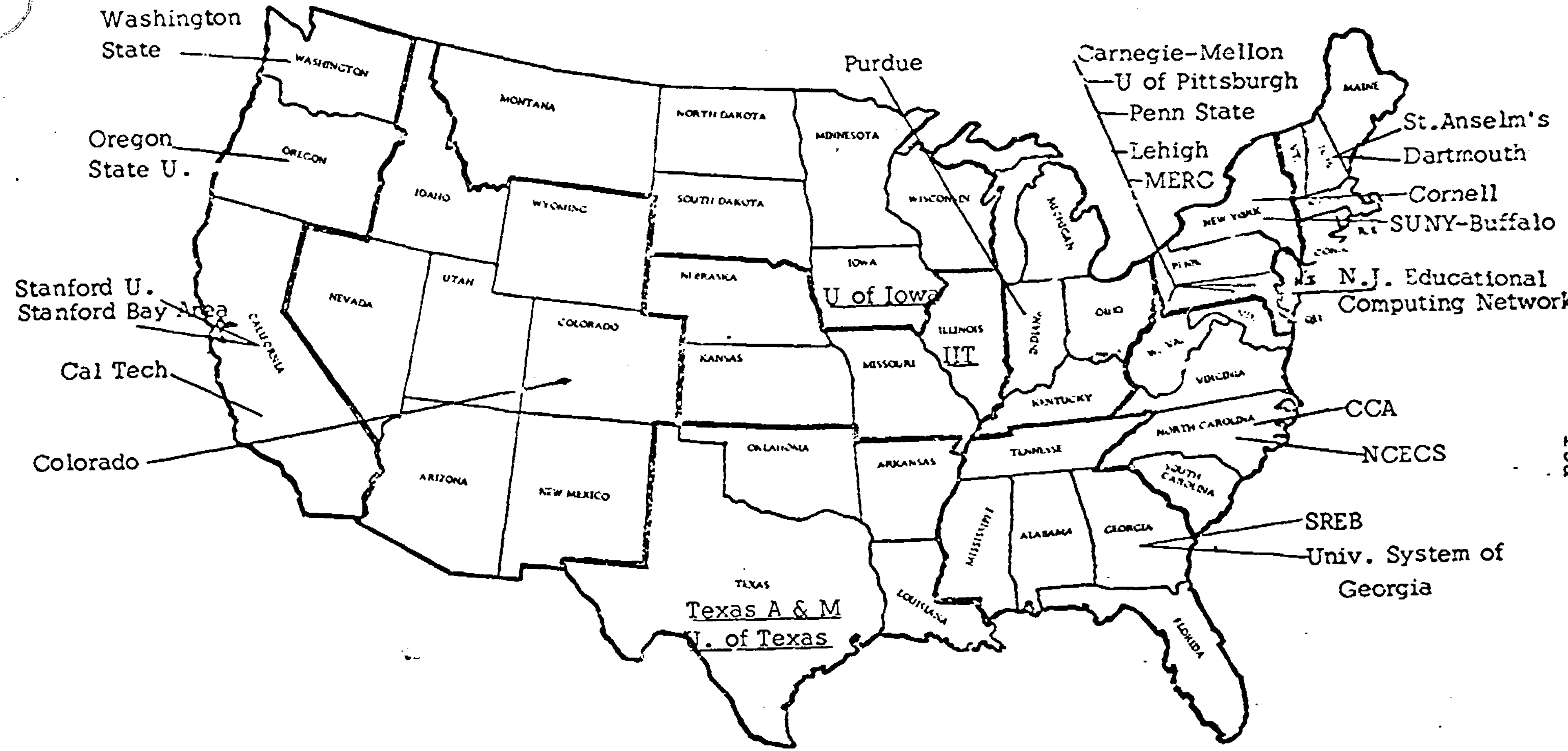

Figure 2: Approximate Location of 25 Networks Established with NSF Support*

*From Ref. (21)

university computing, serves one university, one community college and seven undergraduate colleges.

A recent article by Greenberger, et al.,[22] documents a movement in research and education towards regional and national resource sharing via networks. The benefits of such sharing include:

--"Greater variety and richness of available resources and more flexible intermingling of information with computing services.

--Widened availability of resources to all institutions regardless of size, location or financial status.

--Decreasing cost per unit of information stored or processed because of increasing economics of scale and expanded sharing.

--Payment for information processing as it is obtained, with virtual elimination of the capital costs and budgetary uncertainties currently characteristic of autonomous information and computer center operations."

A major national computer network is ARPANET, developed by the Advanced Research Projects Agency of the Department of Defense (See Figure 3). The ARPANET system interconnects large and specialized computing facilities, many in universities, across the United States. ARPANET permits sharing of specialized and expensive-to-duplicate hardware and software by about 30 major computers on the U.S. mainland linked by 50 landlines and is now linked to Hawaii via satellite.

Networks have also been developed for a variety of other uses. NSF is supporting development of regional systems for science information, including one focusing on chemistry and biology in Georgia. A network has been developed to provide on-line shared cataloging services for 48 colleges and libraries in Ohio by the Ohio College Library Center and is being extended to other states. A national system for on-line search of the medical library of the National Library of Medicine has been established called MEDLINE.

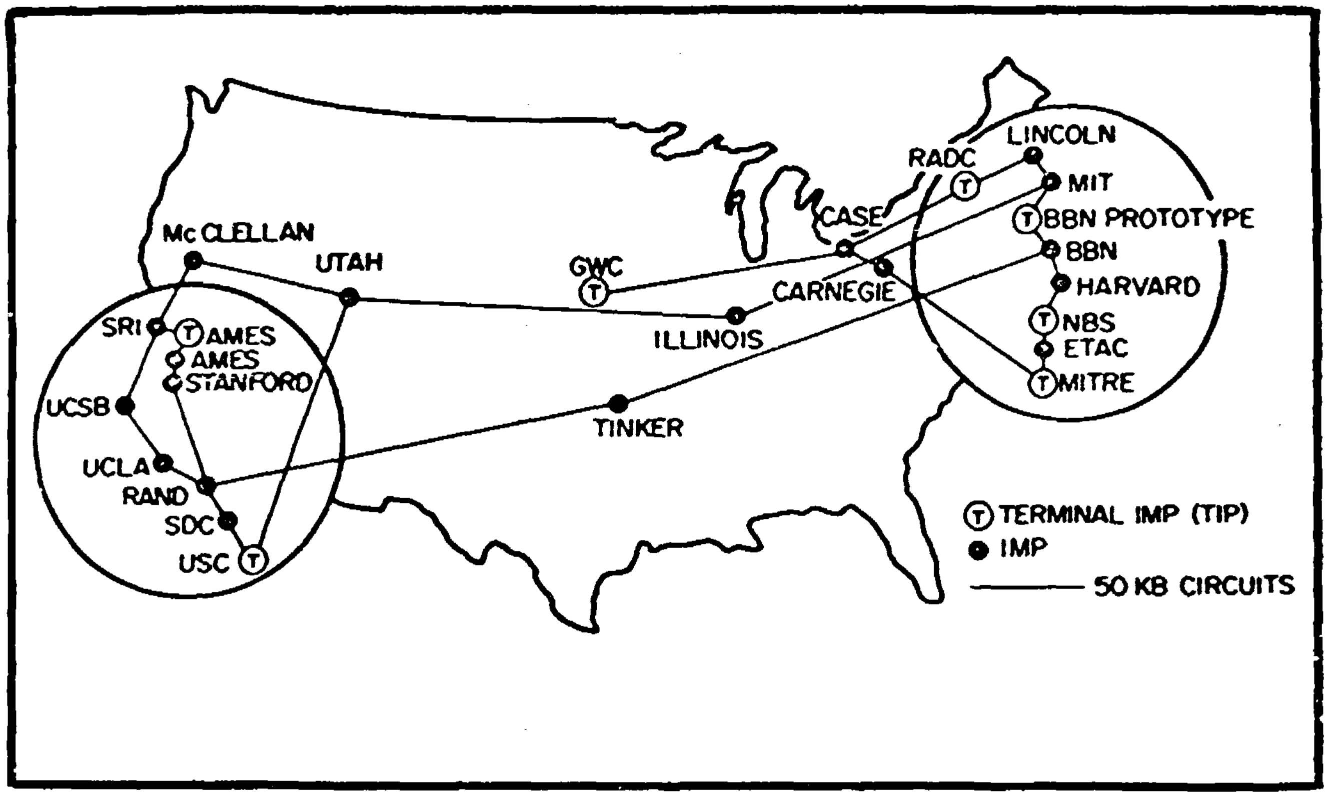

Figure 3: ARPA Network, Geographic Map, March 1972*

*from Ref. (23)

The extent to which networks will gain acceptance would appear to be affected by a number of factors. Among the technological trends which Greenberger, et al.[22] see as beginning to alter the organization of research and education computing services are:

1. The development of powerful, popular minicomputers.
2. Increasing acceptance of remote computing via either time-sharing or remote job entry.
3. Improvements in computer communications technology, data transmissions and switching procedures which is making "networking" easier and less costly.
4. Development of large, inexpensive computer memories, tending to favor centralized information storage.

Although some of these trends would appear to be contradictory, Greenberger, et al. see them giving the computer user more freedom from the local computing center and more options. Harvard is cited as an example of a university which gave up its large central computing facility and which is searching nationally for the best service available for each application.[22]

There are clearly some constraints on the development of computer and information networks. One of these, the financial constraint, is ever present. Another involves the question of whether such networks can be properly managed. These matters are discussed in some detail in the study of regional networks by Weingarten, et al.[22]

D. Communications Satellites

1) Introduction

The history of experiments with satellites for educational communications in the U.S. dates back to January 4, 1970, when the Corporation for Public Broadcasting (CPB) initiated an experiment in transcontinental interconnection employing NASA's Applications Technology Satellites 1 and 3. The objectives of this experiment were technological, the primary one being the evaluation and optimization of a transcontinental satellite link between the East and West Coast for video interconnection using medium sized receivers (30-40 foot antennae) in an urban environment. Since then a number of educational communications demonstrations and experiments using ATS-1 and 3 satellites have been completed or are continuing (see Table 2). With the sole exception of the CPB transcontinental interconnection experiment conducted using C-band (4 and 6 GHz) transponders, experiments continuing or completed to date have employed Very High Frequency (VHF) transponders onboard ATS-1 and 3--using frequencies that are not assigned for operational services and that are incapable of accommodating wideband or high-data rate communications such as television relay/distribution. The experiments conducted to date on VHF involve delivery of Computer-Assisted Instruction (CAI) to rural areas; lecture, seminar and data exchanges among institutions of higher learning; and, delivery of educational/instructional radio for public education and teacher development. Some satellite experiments pertinent to higher education will now be discussed.

2) <u>The PEACESAT Project</u>

The stated purpose of the PEACESAT project (Pan Pacific Education and Communication Experiments by Satellite) is to demonstrate the benefits of currently available telecommunications technology when applied specifically to the needs of sparsely populated, less industrialized areas of the world. The project, initiated by the University of Hawaii, provides an "intercontinental laboratory to develop improved communication methods for educational, health and community services in the Pacific and a base for long range planning." [24]

The educational communication satellite system portion of PEACESAT has been operating and under development since April 1971 and uses NASA's ATS-1 satellite. The system utilizes low cost ground stations with both receive and transmit capability. These terminals, costing about $7,000 each, permit two-way voice and xerox facsimile from all locations. Some

Table 2: Applications Technology Satellite Educational Communications Experiments*

·Completed	Concluded	Spacecraft	Purposes
Corporation for Public Broadcasting	March 1970	ATS 1, 3	Transcontinental Interconnection
Stanford University	June 1972	ATS-3	Computer-Assisted Instruction Delivery to Rural Areas.
·Continuing	**Started**		
State of Alaska (National Library of Medicine, National Public Radio, and U.S. Office of Education)	June 1970	ATS-1	Educational/Instructional Radio; Teacher Training
University of Hawaii	March 1971	ATS-1	Pacific Interconnection of Institutions of Higher Learning.
Stanford University/ CNAE, Brazil	April 1971	ATS-3	Lecture, Seminar, Data Exchange.
·Approved	**Estimated Start**		
DHEW/CPB/NASA (Alaska, Appalachia, and Rocky Mountain States	Spring 1974	ATS-F ATS 1, 3	ETV Distribution and Limited Interactive Services.
India/NASA	Summer 1975	ATS-F	ITV Broadcasting
·Pending			
A Number of Proposals for Experiments using CTS	Winter 1975	CTS	Computer-Assisted Instruction (CAI) distribution; Inter-institutional resource-sharing; New arrangements for delivery of educational services - learning centers and homes; and, delivery of health-care instruction to medics in isolated areas.

*from Ref. (30)

locations also will have slow-scan TV and teletype capability.

A pilot educational satellite system linking Hilo (Island of Hawaii) and Honolulu (Oahu) began operating in April 1971 and is claimed to have offered the first college course taught via satellite, the first satellite interconnection for library networking and the first intrastate satellite network in the U.S. In January 1972, universities of other countries were added to the system. According to PEACESAT literature, time zone differences and language and dialect differences have not been a problem.(24)

As of February, 1972, ground terminals had been established at the University of Hawaii-Manoa Campus (Island of Oahu); Hawaii Community College Campus and Hilo College (Island of Hawaii); Wellington Polytechnic Institute at Wellington, New Zealand; and the University of the South Pacific at Suva, Fiji. Ground terminals were also being test operated or planned for a variety of other locations in the pan-Pacific area.

In June, 1971, two classes, Speech 150 in Hilo, Hawaii, and Speech 145 in Manoa Campus, Oahu, participated in joint activity via satellite. Students engaged in game activity, using two-way voice communication. Facsimile transmissions were also used. Activities concentrated upon included intelligibility, problem solving, information gain, communication of feelings, and determining attitude from speech expression. An important aspect of this experiment was the use of interactive, two-way communication which is deemed of particular importance in interuniversity cooperation of a cross-cultural or transnational setting.

Other university level uses include teleconferencing and instructional exchange among widely scattered participants in such subjects as political science, geography, English as a second language, Spanish, Indonesian, communication and teacher education. Subjects of mutual interest discussed by participants have included student government, Pacific Island broadcasting, foreign investment, race relations and ethnic studies. Special projects dependent upon the system are developing including a student newspaper news exchange, a non-commercial radio news service, and international debates on subjects such as tourism.

Other uses of the system have included the transmission of library materials from one campus in Hawaii to another which has appreciably speeded up service. Formerly, Hilo faculty wishing Hamilton Research Library materials waited 3 to 9 weeks for the materials to arrive. Using PEACESAT, orders are transmitted over the system via facsimile (xerox). Magazine articles are delivered over the system within 48 hours and books by mail within 96 hours. The service was to have been extended between the University of the South Pacific and Hawaii.(24)

PEACESAT has also been used for communication related to research to combat starfish invasions and disease epidemics, for medical consultations concerning infectious diseases, by the Hawaii Agricultural Experiment Service to conduct seminars with its offices and agents, and to broadcast the investiture of the Chancellor of the University of Hawaii.

The guidelines for requests for use of PEACESAT are interesting. They include:(24)

"1. The request must be a joint request. The more locations involved in the service the better.

2. Any planned exchange should require the use of instant two-way communication. If a project can be equally well served through use of other communication facilities, those other facilities should be used rather than PEACESAT.

3. The use should be a benefit to each institution participating in the exchange. PEACESAT is not designed for one-way information dissemination.

4. The project should have a definite education or social purpose.

5. All projects must be stricly non-profit. Only non-profit organizations and institutions may use the system.

6. In general, new kinds of uses have preference. Evaluation of results is encouraged. And pilot projects which demonstrate long range social improvement are sought."

3) The ALOHA System

Paralleling the development of the PEACESAT system has been another development at the University of Hawaii which gives promise of providing computer-communication inputs to communication satellite transmission. In September 1968, the University initiated a research program to investigate the use of radio communications for computer-computer and console-computer links. The remote-access computer system--The ALOHA System--being developed as part of that program is planned to link interactive computer users and remote-access input-output devices at community colleges and research institutes away from the main campus of the University of Hawaii to the central computer via UHF radio communication channels.(25)

The ALOHA System is also actively pursuing the possible development of a Pacific Educational Computer Network using wide-area satellite channels in the "packet communication" mode to permit sharing of specialized computing resources and low-cost utilization of computers located in differing time zones during off-peak hours.(26) In January of 1973 a planning meeting was held at the University of Hawaii for such a Pacific Educational Computer Network. At that meeting, experience to date in extending the ALOHA system via satellite was described. In December 1972, a digital communication sub-system involving a single 50 kilobit satellite channel was installed between the COMSAT ground stations at Jamesburg, California and Paumalu, Hawaii. The first subscriber of this service was the ALOHA system which became the first operational satellite node of the ARPANET.* The lease cost of the channel, including ground

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*ARPA has a satellite task force in which many U.S. universities are participating to explore techniques for using wide-area satellite channels for computer-communications and to investigate the economics of satellites for computer interconnection.

links, is about $10,000 per month which, even taking into account projected cost decreases, does not appear feasible for a large Pacific network.[26] However, if the full-duplex 50 kilobit channel could be used to connect a larger set of ground stations in the Pacific, then it could be used by any earth station which views INTELSAT IV. Regulatory barriers need investigation.

The second ALOHA satellite project involves use of the ATS-1 satellite and small ($5,000) ground stations to operate a random access burst mode data channel between the University of Hawaii and NASA/Ames Research Center in California. The University of Alaska plans to join this network in 1973. Further plans call for extension of this network on an experimental basis to ground stations in other countries.

4) Teaching Techniques for Rural Alaska

A 1972 NEA-UNESCO study recommended an in-service project using a communications satellite to overcome the isolation and lack of terrestrial communication among teachers in rural Alaska. The purposes of this experimental project were:[27]

"1. To demonstrate the feasibility of using satellite communications as a vehicle for increasing the professional competencies of teachers in selected remote isolated villages of Alaska.

2. To demonstrate the effectiveness of transcontinental satellite interconnections between two or more widely separated points to deliver information and obtain feedback and interaction between those points.

3. To stimulate the University of Alaska to use satellite communications in expanding professional growth opportunities for teachers in remote villages, in so doing, to make use of resources not otherwise available."

Beginning on January 22, 1973 the National Education Association in conjunction with its State affiliates, Alaska-NEA and the College of Education, University of Alaska, conducted a 16-week satellite radio series with teachers in 17 Alaskan villages. Teachers could take the course, which was coordinated by the Rural Teacher Corps Project, for one credit in the College of Education. NASA's ATS-1 satellite was used along with the National Institute of Health (NIH) satellite uplink and studios in Bethesda, Maryland outside Washington. Villages could talk to villages as well as to the University of Alaska and three NEA staff members at Bethesda. Six persons took the course for credit and others audited.

The satellite seminars, which featured two-way voice interaction covered topics listed in Table 3. Evaluation of the overall program was generally favorable.(27) The satellite was also used to provide emergency diagnosis of medical problems during this period.

A set of experiments are also being carried out to determine the technical feasibility of transmitting medical information via ATS-1 with low-cost small earth stations.(28) This project, being sponsored by the Lister Hill National Center for Biomedical Communications, involves the Universities of Wisconsin, Stanford University, and the University of Washington, Seattle.

The above experiments have involved interactive communication with voice and digital data only. These limitations are imposed by the relatively low power and small channel capacity of the ATS-1 and 3 satellites. These satellites, now well beyond their design lifetimes, are shortly to be joined by the ATS-F and CTS satellites which will permit expanded activity of a type now to be described.

5) <u>The Health-Education Telecommunications Experiment</u>

The Health-Education Telecommunications (HET) experiment, jointly sponsored by NASA, the Department of Health, Education and Welfare (DHEW), and the Corporation for Public Broadcasting (CPB), will involve educational experiments in Alaska, Appalachia, and the Rocky Mountains. The experiment, scheduled for start in late spring of 1974, is to employ the

Table 3: Satellite Seminar Schedule, Spring 1973*

January 22	"Open Classrooms: Suggestions on How to Get Going". Dr. Robert McClure, NEA, Washington, D.C.
January 29	"Open Classrooms in Rural Alaska" Mike DeMarco, CNER, University of Alaska
February 5	"Self-Responsibility and Learning" Sandy Hamilton and Bob Maguire ASOS, Allakaket, Alaska
February 12	"Children as Teachers" Gaylen Searles, Alaska Rural Teacher Training Corps, University of Alaska, Fairbanks
February 19	Holiday
February 26	"Non-Graded Approach in Tanana" Eileen Crooks, ASOS, Tanana Ann Howard, ASOS, Tanana Rudy Howard, ASOS, Tanana Max Meeker, ASOS, Tanana Judy O'Donnell, ASOS
March 5	"New and Pending Legislation Affecting Rural Schools" Bob Cooksey, NEA-Alaska, Juneau Dr. Marshal Lind, Commissioner of Education, Juneau Senator Terry Miller, President of the Senate, Juneau Dr. Helen Beirne, Chairman of House, Health Education and Welfare Committee, Juneau
March 12	Continuation of February 26 presentation, plus: "Problem Learners in the Non-Graded Classroom" Mary Moses - ASOS, Tanana
March 19	"This Works for Me" Karen Clark, Alaska Teacher of the Year, Two Rivers
March 26	"Language and Learning in Rural Alaska" Dr. Michael Krauss, Alaska Native Language Center, University of Alaska

*from Ref. (27)

Table 3: Satellite Seminar Schedule, Spring 1973 (continued)

April 2	Continuation of March 26 presentation
April 9	"Effective Teachers of Indian and Eskimo Students" Dr. Judith Kleinfield, Center for Northern Educational Research, University of Alaska
April 16	"Views from a National Perspective" Mrs. Catherine Barrett, President, NEA Rep. Don Young Dr. Harold Wigren, NEA, Washington, D.C.
April 23	"Teaching Strategies for Rural Alaska" Dr. Charles K. Ray, College of Behavioral Sciences and Education, University of Alaska
April 30	"Community Involvement in Education" Jim Williams, ASOS, Ft. Yukon Carolyn Peter, ASOS, Ft. Yukon Bill Pfisterer, ARTTC, Ft. Yukon
May 7	"Emerging Trends and Issues in Rural Alaskan Education" Dr. Frank Darnell, Center for Northern Educational Research, University of Alaska
May 8	Final Evaluation Session

ATS-F satellite to distribute health and educational material to public broadcasting stations, cable television headends, translators and community centers in S-band (2500 MHz) using low-cost/receive terminals ($3,300-$3,500 per unit in quantities of 100 or so). It will also use VHF transponders onboard the ATS-1 and 3 spacecrafts to accommodate limited narrowband interaction (voice or low-speed data/facsimile) from selected remote installations. Figure 4 shows the proposed communications network for the HET experiment.[29]

The HET experiments are planned to explore, in addition to demonstrating the feasibility of distributing ETV signals to low-cost terminals, the three dimensions of educational delivery arrangements--the hardware, software, and human-support elements. These are to be weighted in different ways to assess the impact of different combinations on the learning, participation, and opinions of the program-receiving audience. The programming is to focus upon career education, and in-service teacher development. The total cost of the entire experiment exclusive of the space segment, is estimated to be in the range of $11-12 million.[30]

The scale, duration and funding support of HET experiments and the technology involved, with particular respect to ETV distribution in S-band to low-cost terminals make it the first true demonstration of the capabilities offered by high-power satellites even if it touches upon only a few of the opportunities that satellites potentially may provide.

Higher education's participation in the HET experiment will be somewhat limited. In the Rocky Mountain area, in-service training sessions for teachers will be carried out using one-way video, two-way audio and digital interaction.[31] The University of Kentucky will carry out a graduate teacher training project by satellite involving teachers at regional education service agencies in ten Appalachian states.[31] Alaska's participation in the HET experiment is currently directed towards elementary school students. The NEA is also

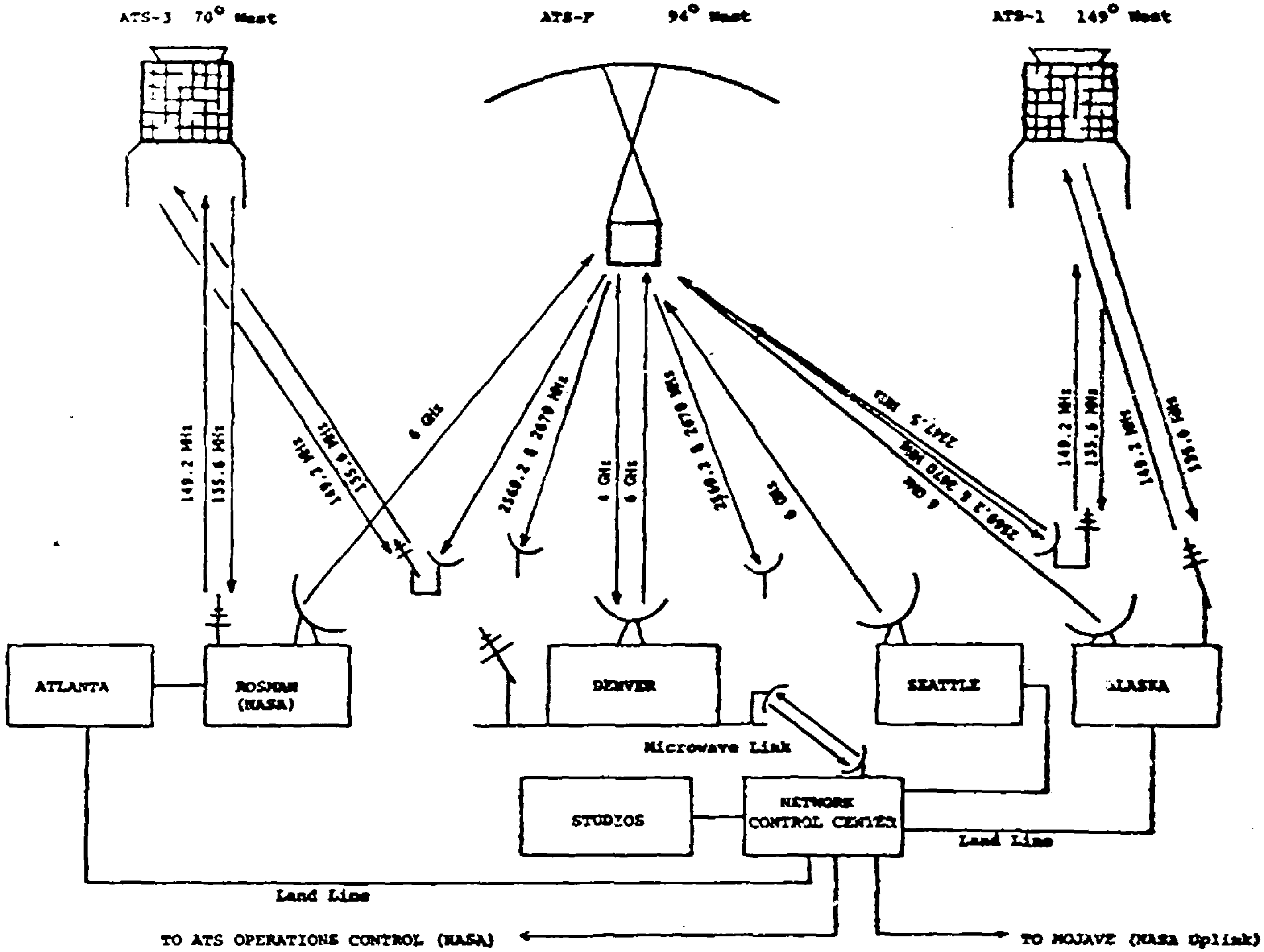

Figure 4: The HET Communications Network*

*from Ref. (29)

interested in continuing its efforts directed towards professional development of teachers in Alaska through use of ATS-F.[31]

The ATS-F satellite will be available over the U.S. for one year. It will then be positioned so as to view the Indian subcontinent for purposes of carrying out SITE, the Satellite Instructional Television Experiment. Details of this experiment involving family planning, improved agricultural practices, national integration, general school education and teacher training, are described elsewhere.[32,41]

One should bear in mind that ATS-F is not a spacecraft designed exclusively for S-band communications for U.S. domestic applications but it is more like a bus that carries onboard a number of other communications and scientific packages. In fact, 2500 MHz S-band transmitters for the HET experiment were a late addition to the ATS-F payload and the lateness of the proposal inhibited efforts to tailor antenna foot-prints for optimum coverage of the regions involved. The complications involved in providing for interactive communications, simultaneous coverage of all the regions, and inter-region communication are well illustrated by Figure 4.

In brief, the HET experiment is the first major U.S. educational experiment that will provide valuable information for structuring educational telecommunications networks and, in particular, determining the role of communication satellites vis-a-vis other technologies in such networks. But the information provided by one year's experience with limited satellite time and capabilities will certainly not be sufficient to resolve all the questions that stand in the way of developing operational telecommunications-based networks/delivery systems. The HET experiment represents only the first step of an iterative process that leads to policy determination and the possible development of operational systems.

6) Communications Technology Satellite

Communications Technology Satellite (CTS), a Canadian program in cooperation with NASA, is to be launched in the winter of 1975. Like ATS-F, it contains a high-power transponder which allows use of inexpensive and small earth terminals, but in the Ku-band (12 and 14 GHz). A number of proposals for user experiments with CTS have been submitted by a variety of U.S. organizations and institutions to NASA. These include the delivery of Computer-Assisted Instruction (CAI), inter-institutional and inter-regional resource sharing, and experiments with new arrangements for the delivery of educational services, both within and outside the framework of the traditional college/university setting.

Provisional approval has been given by NASA for experiments involving the University of Texas, the University of the State of New York, Stanford University and Carleton College. The New York experiment will link major bibliographic and research centers in the U.S. and Canada and enable documents to be delivered from 12 resource libraries to 50 receiving libraries. Stanford and Carleton will use two-way video to demonstrate curriculum sharing between two institutions, one of which has an engineering school and one of which does not. The Texas experiment will develop a health science continuing education network for use in low density population areas.

7) After ATS-F and CTS?

In January, 1973, NASA decided to phase out its communication satellite R and D program and to cancel the launch of the ATS-G spacecraft which was to follow ATS-F. Cancellation of the ATS-G launch eliminates the back-up for ATS-F, in the event ATS-F does not reach its orbit successfully or fails in orbit. It also eliminates the alternative of continuing the HET experiment beyond one year without any major change in the ground segment implemented for experimentation using ATS-F. Communications Technology Satellite (CTS), a joint U.S.-Canada program, is to be launched in the winter of 1975 and provides the only avenue for continuing HET experimental programs and initiating new ones. However, CTS, though designed to serve low-cost terminals, is to operate in the Ku-band (12 GHz down-links and 14 GHz up-links) and, hence, will require major alterations in the ground segment laid out for ATS-F. Moreover, the cancellation of plans for ATS-H and I remove any back-up for CTS. It should also be kept in mind that current educational satellite experiments rely heavily upon ATS-1 and ATS-3 which are somewhat limited in life (being past their design lifetime), power and channel capacity.

The reason given by NASA for phasing out its communications satellite R and D program was that the private sector in the U.S. has reached a stage where it is fully capable of supporting necessary R and D in this area and there is no longer any need for NASA initiatives and support. There are in fact a generation of commercial domestic communications satellites about to come into being. However, in general, these satellites are relatively low power satellites which serve expensive earth terminals. They are designed primarily to serve commercial markets and offer few incentives for educational use. Although it is conceivable that private interests may wish to stimulate educational usage, particularly interests related to cable television, most of the educational communications experiments and planning to date have been oriented towards the development of high-power satellites serving inexpensive earth terminals. This line of development appears to be in serious danger of being cut off.

Figure 5 illustrates possible educational satellite services in the U.S. and Table 4 summarizes primarily roles in education which satellites may provide. If and when operational educational services are implemented, they are likely to be developed in conjunction with local distribution facilities such as cable-television systems, Instructional Television Fixed Service (ITFS) systems, regional terrestrial networks, and broadcast facilities. The use of satellites for direct delivery of services to roof-tops of schools and

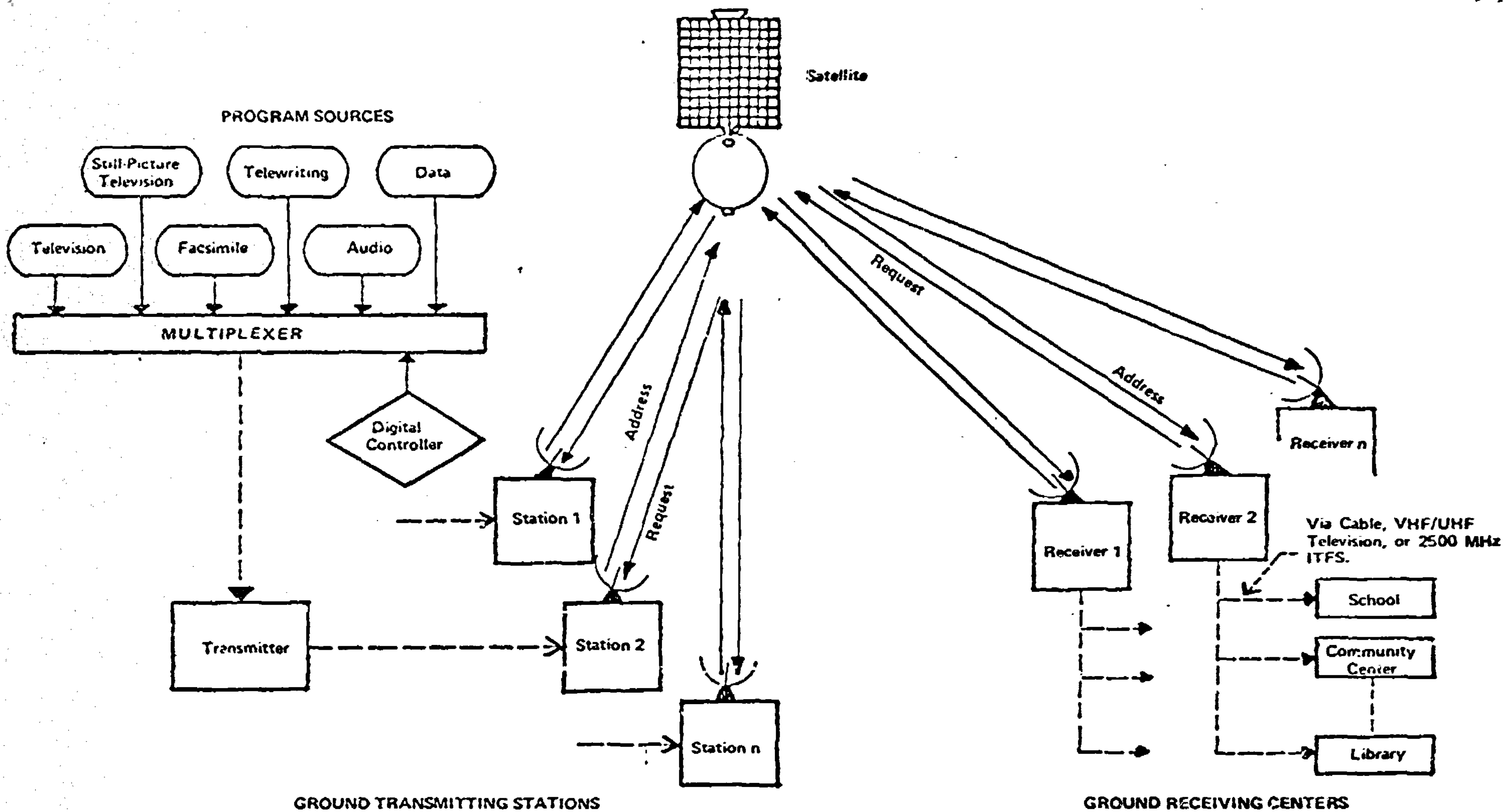

Figure 5: EDUCATIONAL SATELLITE SERVICES*

*from Ref. (40)

Table 4: Primary Roles for Satellites Towards the Delivery of Certain Educational Communications Media and Services*

SERVICE	PRIMARY ROLES FOR SATELLITES
Instructional Television	Direct delivery to schools and learning centers, to broadcast stations, ITFS and cable headends for further redistribution.
Computer-Assisted Instruction	Delivery of CAI to small, remote institutions, particularly those 70-80 miles or more away from a major metropolitan area.
Computing Resources	
Multi-Access Interactive Computing	Delivery of interactive computing to remote institutions for the purposes of problem solving and implementation of regional EIS.
Remote Batch Processing	Delivery of raw computing power to small, remote institutions for instructional computing and administrative data processing.
Computer Interconnection	Interconnection of the computer facilities of institutions of higher education and regional computer networks for resource sharing.
Information Resource Sharing	
Interlibrary Communication	Interconnection of major libraries for bibliographic search and interlibrary loans, etc.
Automated Remote Information Retrieval	Interconnection of institutional and/or CATV headends with major information storage centers.
Teleconferencing	Interconnection of educational institutions for information exchange without physical movement of the participants and for gaining access to specialists.

*from Ref. (30)

learning centers is of interest in areas where topographical and/or demographic conditions make local distribution and interconnection systems less attractive economically--areas such as Alaska, the Rocky Mountains and parts of Appalachia. Satellites look promising for delivery of educational services to wide but sparsely populated areas and for interconnection of cable systems, but the cable-television head-end interconnection is not necessarily promising unless educational interests can make greater inroads into local cable systems. Cable systems tied together by satellite could conceivably provide a second interconnection for public television programs.

IV. WHAT MIGHT BE: FUTURE OPPORTUNITIES FOR LARGE-SCALE TELECOMMUNICATIONS

A. Forecasting Future Utilization

Robinson (33) has recently completed a study using the Delphi technique with the objective of forecasting the future use of technology in education. Quantitative predictions of utilization were made for the years 1980 and 1990 for three classifications of technology; 1) television instruction, 2) computer instruction and 3) information services.* The emphasis was upon large-scale educational telecommunications technology--that technology which could be organized for distribution through large systems and networks. Six categories of education were considered: 1) early childhood education, 2) primary and secondary education, 3) higher education, 4) adult and continuing education, 5) vocational and technical education and 6) special education. Robinson also forecast values and opinions for the year 1990 concerning education and constructed a scenario of what education in 1990 might be like.

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*This latter category includes library information resource sharing, time-shared computer networking, and management information systems, among others.

Robinson points out some of the limitations of such a Delphi study. Although a fairly representative panel of participants was sought, the majority of respondents were communications technologists and educational planners concerned with the use of technology and telecommunications in education. Teachers and school administrators generally seemed reluctant to participate. The forecasting problem is a difficult one because of the lack of information on current utilization and the many social forces at work.

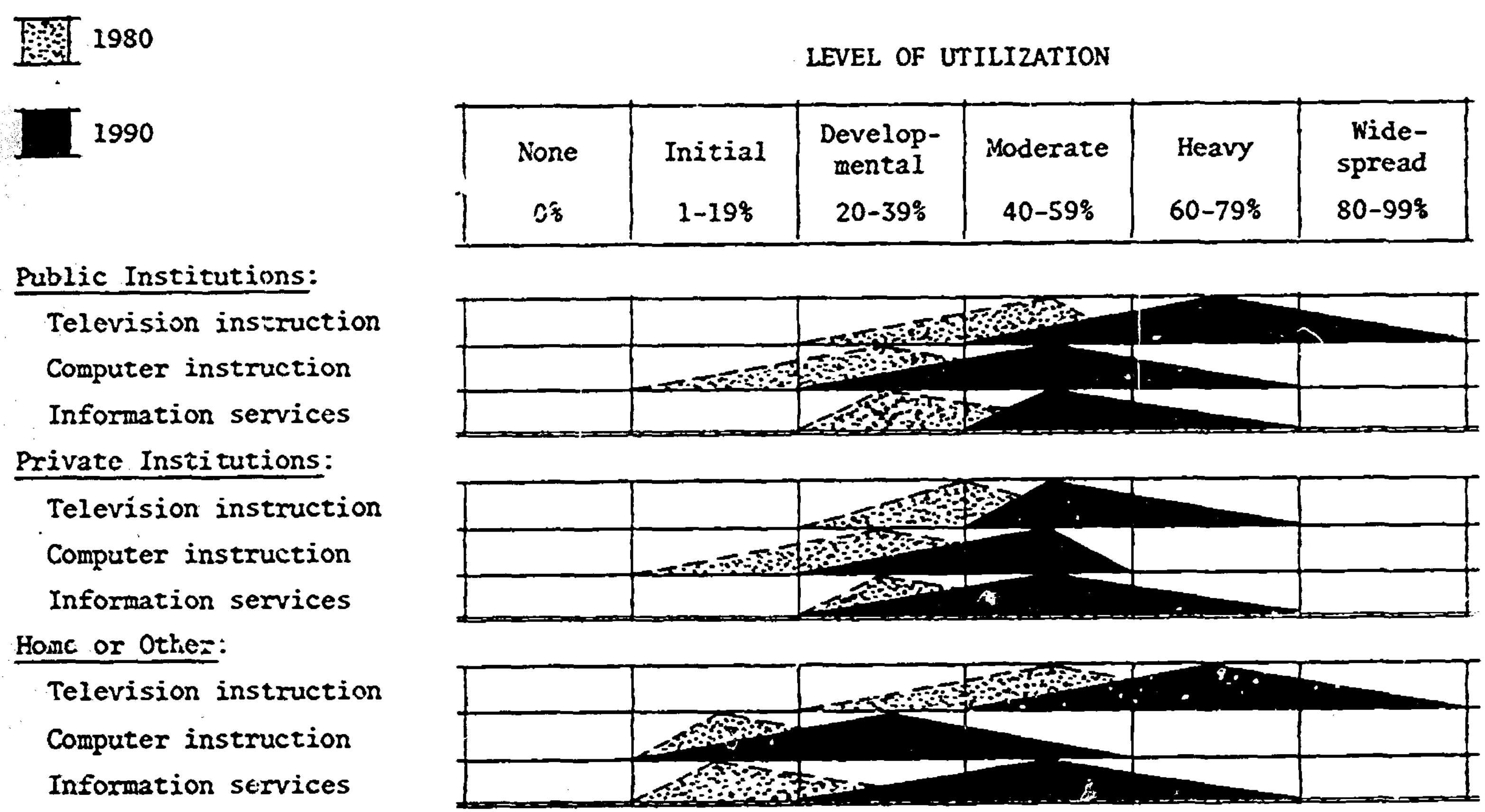
Figure 6 shows the predictions of the level of utilization in higher education by 1980 and 1990. Television is the medium of widest use, particularly in public institutions and homes. Substantial utilization is predicted for all categories.

Robinson's results may be compared with other forecasts of instructional technology utilization. The Carnegie Commission on Higher Education predicts that by the year 2000, "a significant proportion of instruction in higher education on campus may be carried on through informational technology--perhaps in a range of 10 to 20 percent. It certainly will penetrate much further than this into off-campus instruction at levels beyond the secondary school--in fact, it may become a dominant theme at a level of 80 percent or more."(6) Forecasts by Bell-Canada for three technologies, namely computerized library systems, CAI, and information retrieval television and visual display systems, predict that in the U.S. and Canada, "extensive development and widespread adopting of educational technology will occur during the late seventies and eighties. It is predicted that the average student at the post-secondary level will spend five hours per week on CAI by 1985."(34)

Forecasts run the risk of either being self-fulfilling prophecies or of being dead wrong. Financial, political, legal, organization and human factors may in large part control future developments. Nevertheless, in the U.S. there are some potentially promising matches between technology and higher education.

These include:

Figure 6: Utilization of Technology in Higher Education*+



*The triangle represents the middle 50 percent of the responses, the peak being the median response.

+from Ref. (33)

1. Reaching wider populations of college students through TV, etc. There is increasing emphasis on "external degree" programs, i.e., programs in which students receive a significant proportion of their education off campus. Although not widespread, some momentum for this approach has been developing. Leading examples of institutions using or contemplating using this approach include Chicago TV College, Miami-Dade Community College, and the proposed Open University of the State of Nebraska. The approach seems particularly promising for reaching people in large state systems or in populated urban areas. Problems associated with financing such efforts have been discussed by Bowen.(14)
2. Continuing professional education. A growing number of universities deliver instruction via television to individuals at industrial and other locations. The Surge Program in Colorado uses videotapes to provide graduate engineering courses to an extensive audience.(16) Some 15-20 universities have developed similar programs, using a variety of delivery mechanisms including videotapes, microwave, and ITFS.
3. Regional computing networks and information networks. There are some thirty examples of regional computing networks in which a large central facility serves a number of outlying colleges.(22) Specialized information networks for various disciplines (health, science, etc.) and for library sharing are being created.

Depending upon support and acceptance, it is possible that these kinds of activities will grow in the future. Although it is not likely that we will see the development of a federal external degree university in the U.S., there is considerable incentive for developing various forms of cooperation. Possible initiatives include pooling of resources for courseware development and assembling a critical mass of users to take advantage of the economies of scale inherent in a large-scale educational telecommunications system which delivers a variety of services throughout the entire U.S. However, there are associated with such a system a host of problems to be overcome which are not primarily technical.[33] Furthermore, the long-term social, legal, political and economic implications of such a system require careful attention before such a system is implemented.

Recently, Singh, Walkmeyer, et al.[38] have attempted to estimate specific channel and delivery point requirements for future educational satellite systems in the U.S., based upon scenarios which identify future opportunities for communications media in higher education. Considered were campus-oriented services, external degree programs, as well as computer and interlibrary networking services. They also developed four alternative organizational frameworks for large-scale educational telecommunications systems: 1) Project Reach: an effort controlled by the Public Broadcasting Service; 2) "CUES", a cooperative public sector consortium of educational organizations; 3) "SKYNET", a commercially owned system which leases channels to educational users, and 4) "PILOT", a public sector effort which eventually is turned over to private industry. These alternatives provide a broad range of options to examine from the point of view of economic and political viability.

B. The World University

One of the purposes of this Symposium is to focus upon the role of communication in the projected world university. For those of us who seek ways in which science and technology may be of service to mankind, this focus immediately brings to mind a host of promises of the kind envisioned by Arthur Clarke in his early writings. Papers have been written about possible uses for satellites to improve the communications system of the U.N.[36] and to provide technical assistance.[37]

The possibilities for opening up two-way communications among students in various parts of the world and for sharing of resources between universities seem appealing.

However, there are a number of important considerations to keep in mind. First, the results are not all in yet concerning the cost-effectiveness of instructional technology in higher education or optimal methods for using the technology. Experiments are not operational systems. Diversity of goals and cultures in some countries may mean that what works in one setting may not work in another. More imaginative efforts are required. Some technology is very costly. Countries, let alone regional or national organizations, may not have the resources to commit. Such commitments on an international scale may only be possible if the political climate is right.

It seems to me that in the near term future, efforts to use telecommunications in education will focus primarily on the national and regional level. However, some limited overtures for incorporating telecommunications uses in some sort of world university framework might be fruitful. The very act of two-way voice communication, though relatively inexpensive may be more meaningful within an international, intercultural framework than in a national one, provided that the groundrules are set up so that one culture or nation doesn't dominate the other. Some limited initial technical cooperation, or exchange of information between university centers in some key area like food production might also be a good initial thrust. As confidence is built, perhaps more activity could be attempted.

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