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ABSTRACT

A survey of literature and information sources disclosed the overall trends for telecommunications technology in education. This report describes both hardware and software aspects of these trends. Hardware trends include microminiaturization, increased message transmission capacity, interactive information flow, more complex and complete information grids, faster and longer long distance communications, and multimedia use of technologies; while self paced instruction, the interdisciplinary approach, greater student involvement, increased stress on relevance, team teaching, and time flexibility are included under software trends. A number of telecommunications systems or devices provide the basis for the discussion of the trends: educational television, closed-circuit instructional television, instructional television fixed service, videotape recording, satellite, cable television, radio, telephony, and information networks. These systems are discussed and evaluated in terms of current developments, applications, and potentials for education, and a final section of the report projects future trends for each of the systems. (Author/SH)

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INNOVATIONS IN TELECOMMUNICATIONS TECHNOLOGY: IMPLICATIONS FOR EDUCATION

by

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Under the Direction of

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ABSTRACT

A survey of literature and information sources in industry, government, and education disclosed the following overall trends for telecommunications technology in education:

Hardware

1. Micro-miniaturization.
2. Increased message transmission capacity.
3. Inter-active information flow.
4. More complex and complete information grids.
5. Faster and longer long-distance communications.
6. Multi-media use of technologies.

Software

1. Self-paced instruction.
2. The interdisciplinary approach.
3. Greater student involvement.
4. Increased stress on relevancy.
5. Team-teaching.
6. Time flexibility.

Each type of telecommunications system or device is discussed in terms of what it is, and what it does, or potentially can do for education. Trends are projected for each technology and its possible applications in and implications for education.

The major problem discovered was lack of specifying instructional objectives prior to application of a technological

breakthrough. It is suggested that state and federal agencies take the lead in reversing this process such that educational innovators, and not technological breakthroughs guide the course of education.

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CHAPTER I

INTRODUCTION

A. SCOPE AND PURPOSE OF REPORT

The purpose of this report is threefold:

1. *to identify current trends in telecommunications technology--their applications and implications for education;*
2. *to discuss these trends, applications, and implications; and*
3. *to project developments in telecommunication technology--particularly their probable impact on education over the next two decades.*

For report purposes, a working definition of "telecommunications," reflecting its common use as a term for methods of long distance electronic communication, has been adopted. Furthermore only telecommunications adapted to, or potentially adaptable to, educational purposes are discussed.

The research only deals with audiovisual media such as film, overhead projectors, or audio tape recorders when they are incidentally utilized with telecommunications technology, as is the case when a film is shown on television.

The report also relates the effects of telecommunications to aspects of education such as student and teacher roles

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in the learning process. The purpose of this is to indicate that a technology, if it is to be effectively used, cannot simply be tacked on to an existing educational environment.

Projections of trends in technology and their probable-possible impact on education are, by their nature, general and provisional. As author-scientist Arthur C. Clark, commenting on the hazards of being a prophet notes, "With monotonous regularity, apparently competent men have laid down the law about what is technically possible or impossible--and have been proved utterly wrong, sometimes while the ink was scarcely dry from their pens" (Clark, 1964, p.1). What Mr. Clark has to say applies equally to those writing with a light pen on a cathode ray tube, perhaps even more so.

B. REPORT RESEARCH PLAN

In accordance with the purposes of this report, the research method is primarily one of surveying, evaluating, and collating primary information sources relevant to telecommunications technology and education.

In order to obtain a balanced overall picture of technological and allied developments in telecommunications and education, information from diverse sources is surveyed and evaluated. The most thorough and current sources represent either government or commercial and noncommercial associations and interest groups. The first source group, government, includes such agencies as the Federal Communication Commission (FCC) and the

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Department of Health, Education and Welfare (HEW). Prominent noncommercial organizations include the National Education Association (NEA), Joint Council on Educational Telecommunications (JCET), National Association of Educational Broadcasters (NAEB), and Educational Products Information Exchange Institute (EPIE).

The industrial interests include both individual companies and industry associations. The most prominent are American Telephone and Telegraph (AT&T), General Telephone and Electronics (GT&E), International Telephone and Telegraph (IT&T), the National Association of Broadcasters (NAB), National Cable Television Association (NCTA), Communications Satellite Corporation (COMSAT), RCA, and Western Electric.

A number of the above publish magazines or pamphlets dealing with various aspects of telecommunications and/or education. Audiovisual Instruction and AV Communications Review, both published by NEA's Department of Audio Visual Instruction (now doing business as the Association for Educational Communications and Technology), are fairly rich information sources, as is NAEB's Educational Broadcasting Review. EDUCOM, a bulletin of the Interuniversity Communications Council, is a forward look at information networks. A newsletter published by JCET is a particularly good monitor of diverse industry and government interests.

The review of published texts revealed no truly comprehensive, current book in the areas covered by this report, although a number of them (see Bibliography) provide a good historical perspective. Finally, the Educational Resources Information Center (ERIC), an educational publication clearinghouse funded by the government, is a rich source of articles collected from a vast number of sources.

C. ORGANIZATION OF REPORT

The text is organized into four chapters:

Chapter I, INTRODUCTION, describes the rationale of the research strategy and report format.

Chapter II, IDENTIFICATION OF TRENDS, is an introductory overview to the report topics.

Chapter III, DISCUSSION OF TRENDS, is a detailed discussion of current trends. Each topical discussion is an information cluster related to a particular technological device or system. Each of these topics is discussed in terms of what it is, what it has done or is designed to do, and an evaluation (including costs where reliable figures are available) of what its implications and potentials are for education.

Chapter IV, PROJECTION OF TRENDS, presents speculations about future trends. The projections are related to the probable technological (hardware) and non-technological (software) developments of each telecommunications device or system. An annotated list of sources recommended for monitoring of trends is also included.

CHAPTER II

IDENTIFICATION OF TRENDS

A. HARDWARE

The term "hardware" is used to refer to all the equipment discussed in this report. For example, television receivers, telephone lines, and microwave antennas are hardware items, whereas programmed instruction, teacher roles, and administrative organization are software considerations. Generally, the hardware is what is used and the software is how it is used.

Hardware, in the past ten or fifteen years, has developed along a number of lines:

1. Micro-miniaturization is evidenced most spectacularly in solid-state electronics. The transistor and the printed circuit have made everything from portable radios to hearing aids smaller, less expensive, more reliable, and easier to use.
2. Increased message transmission capacity can be seen, for example, in satellites where, in the past six years, telephone transmission capacity per satellite has increased over twenty times from 240 to 5,000 circuits.
3. Inter-active information flow means that almost instantaneous two-way communication

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takes place between the sender and receiver of a message. The coaxial cable, used in cable television, can transmit signals two ways so that a student and a "remote" teacher may respond to each other almost as though they were in the same room.

4. More complex and complete information grids provide for linking up any number of locations in a common network such that each may draw on the information sources of another. Libraries, for example, may be centrally located and yet provide service by electronic transmission to any number of remote users. Systems made up of libraries, or information banks, may be integrated into a vast information grid available for access by an unlimited number of users.

5. Faster and longer long-distance communications developments are associated with satellites and direct long-distance dialing, for example.

6. Multi-media use of technologies involves two ideas. One is the concept of using the medium most suitable to attaining a particular learning goal and the other means that different media may be used in combination to achieve what each cannot do separately.

An example of this is an audiovisual retrieval system linking a computer to a learning carrel equipped with an audio tape machine and a video screen.

B. SOFTWARE

"Software" refers to all aspects of how people use the technologies they create. Traditionally, software development lags behind hardware development. Telecommunications has been no exception. After some early disappointments, the pace (for purposes of this report restricted primarily to instructional methodology) of software innovation has begun to pick up. As with hardware, a number of trends are emerging. Some of these are:

1. Self-paced instruction means that the student may determine his learning pace and, to a certain extent, his learning strategies. The prescribed information is presented in such a manner that students may engage and progress through it according to their abilities and desires.

2. The interdisciplinary approach embodies the idea that subjects, usually presented as separate bodies of information, are interrelated in many different ways. Recently some schools, reflecting increased student

concern for the environment, have combined aspects of political science courses with those of chemistry courses.

3. Greater student involvement involves allowing the student to take a more active part in the educational process, both as a learner and, if you will, administrator.

4. Increased stress on relevancy is reflected primarily in the growth of community colleges where more emphasis is placed on attaining skills and knowledge that are directly applicable to a social or economic need.

5. Team-teaching is seen in a number of ways. One is two or more teachers working with a group of students--each teacher, perhaps, concentrating on one aspect of the instructional situation. Another way is to consider the production personnel of a televised instructional program as a teaching "team."

6. Time flexibility is a concept that is particularly inherent in applications of telecommunications technology to education. Machines, and the information they harbor, may be called upon any number of times at any hour of the day or night.

In all, these and other software developments may be thought of as components of systematically designed learning environments stressing individualized learning and education of the "whole" student.

C. EVALUATION

With each new development in telecommunications technology, there have been two immediate responses, or to be more accurate, a response and a counter-response. The response has been an exclamation of the exciting educational opportunities to be derived from the new development. This has been followed by a negative counter-response pointing to poor educational experiences with telecommunications and the fear of yet further depersonalization of the learning process. These views, both response and counter-response, are partially valid. For those excited by the possibilities, telecommunications' inherent characteristics of almost instantaneous message duplication, transmission, preservation, and retrieval, are supportive. In all fairness, the detractors admit that telecommunication evaluation is based on applications that do not give the technology its head, nor are the research procedures totally reliable. The major valid criticism, voiced mostly by students, has been lack of timely student-teacher interaction, or feedback. The teachers too have had grounds for complaint in that instructional use of telecommunications has placed unreasonable demands on their time and skills.

Recent developments in the areas of inter-active vision, applications of telephone technology such as tele-

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classes, and computer-directed audiovisual retrieval systems, can diminish the problem of feedback. Teachers too have reason to hope that their dream of being freed from administrative distractions in order to teach, and teach each child with greater individual involvement, will be realized. Perhaps the misapplication of telecommunications to education in the past will insure that those mistakes will not be repeated. Given the potential of recent hardware-software innovations, the prospects for increased learning and cost effectiveness appear promising.

CHAPTER III

DISCUSSION OF TRENDS

The discussion of trends is organized into nine topics. Each topic is an information cluster related to a particular technological device or system. First the device or system is defined in terms of its components and their functions. Next, generally related current developments, both technological and non-technological, are listed. Each device or system is then discussed in terms of its existing applications to education. Particular attention is given to software considerations in point B., CLOSED-CIRCUIT INSTRUCTIONAL TELEVISION. Much of this discussion may be equally related to other television systems. These systems or devices, though discussed separately, are interrelated. These relationships are indicated. Finally an evaluation of each device or system is given in terms of its educational implications and potentials. Costs, where representative, are also set forth.

Again, the projections of trends in these areas are presented in Chapter IV.

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A. EDUCATIONAL TELEVISION

1. Introduction. For purposes of this report the term "educational television," ETV, is used to designate over-the-air open broadcasts of educational or cultural programs by non-commercial publicly funded television networks such as the Corporation for Public Broadcasting (CPB) or National Educational Television (NET). NET programming may originate at any one of the network's approximately 200 local stations and may be distributed among all or a number of them. Programming is diverse, reflecting the many publics NET attempts to serve. The total network reaches about 74 percent of the American people (Committee on Telecommunications, 1971). ETV stations are received over regular VHF-UHF channels and may be brought in by cable television.

1.1 The Corporation for Public Broadcasting was established by Congress under Title II of the Public Broadcasting Act of 1967. There was a total of 124 ETV stations at the end of 1966 classified as follows (Carnegie Commission, 1967, pp. 21-22):

1. School stations, licensed to school systems or school districts and brought into being primarily to serve elementary and secondary schools. There are 21 such stations.

2. State stations, licensed to state boards of education or similar state agencies. These, too, have been brought into being to serve primary and secondary education. There are now 27 such stations.

3. University stations, licensed to public rather than private colleges and universities. They have been brought into

being primarily as an extension of ordinary university activities, including continuing education; in some cases they are also used as instruments for instruction or communications. There are now 35 such stations.

4. Community stations, licensed to non-profit corporations. These stations predominate in the large metropolitan areas, and in general are the largest and best-financed stations. There are now 41 such stations.

Financing was primarily through local and state governments and private foundations such as the Ford Foundation. The Carnegie Commission recommended that support on local and state levels be increased and that the federal government charter a nonprofit,nongovernmental corporation that would support local and network production and distribution of cultural and public affairs programming. One intent of the 1967 act was to "establish at the earliest possible date a scheme of permanent financing which would free public broadcasting from the need for annual appropriations" (JCET News, 1971, p, p.3).

1.2 Current developments, both technological and non-technological, include:

1. The World Administrative Radio Conference on Space Telecommunications (WARC/ST), a United Nations member organization representing almost 150 Third World, Communist Bloc, and Western countries, at a recent conference adopted rulings that would reserve the 2500-2690 MHz band for public service broadcasting via

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satellite. This ruling, agreeing in principle with recent FCC stands on terrestrial allocation of the 2500-2690 MHz band, opens the way for broadcast satellites to transmit educational programming to special low-cost terrestrial receiving systems (JCET News, 1971, u).

2. NASA, in cooperation with the Department of Health, Education, and Welfare (DHEW) and CPB, in 1973-74 will test the economical and technical feasibility of its Applications Technology Satellite (ATSF) to broadcast educational programming to low-cost ground receivers in remote areas of the United States (JCET News, 1971, c).

3. The FCC recently ordered American Telephone and Telegraph (AT&T) to complete construction by 1973 of a 110 point interconnected communications system for CPB. Such a system would be dedicated to CPB (i.e. not interruptible for other purposes). Charges for the service, based on incremental costs to AT&T, will grow to $4.9 million by 1974 (JCET News, 1971, f).

4. CPB-PBS (Public Broadcasting Service) filed a joint request, backed by the Ford Foundation, to the FCC asking for free satellite broadcast service for a limited and carefully defined educational network. The request was based on a Ford Foundation report recommending the creation of Broadcasters' Non-Profit Satellite Corporation (BNSC). This Corporation would lease satellite relay facilities to commercial broadcasters at costs lower than normal satellite connections (Norwood, 1969). The BNSC profits would finance CPB's efforts via satellite. The request to FCC and creation of BNSC are still not resolved (JCET News, 1971,q).

5. A recent FCC proposal that 5 percent of commercial cable television receipts support CPB-ETV programming has not been acted upon. CPB is not in favor of the plan fearing it might reduce its support from the federal government (JCET News, 1971, l).

6. This fall, CPB will provide a five-day per week program schedule to 202 public televisions stations (JCET News, 1971, r).

7. COMSAT has recently proposed creation of two domestic satellite systems--one to serve AT&T long-distance telephone service, the other to serve as a multi-purpose system. Circuits on the second system would be available to CPB. No costs have been mentioned (<u>JCET News</u>, 1971,b).

8. The Department of Health, Education, and Welfare has recently favored use of cable television to extend the coverage of public broadcasting. One advantage cited is cable TV's possibilities for two-way communication (<u>JCET News</u>, 1971,j).

9. <u>Sesame Street</u> was recently evaluated in selected homes in Winston-Salem, North Carolina. The controlled audience-program response experiment was made possible through the use of cable television technology (<u>JCET News</u>, 1971, s).

10. A closed circuit, two-way microwave-linked, long-distance medical consultation experiment has recently been completed, after 22 months of service, in Ohio. (<u>JCET News</u>,1971, t).

11. President Nixon's 1972 budget requests include 30 million dollars for CPB, an

additional five million available to match donated funds, and an additional 10 million in contingency funds that would provide the beginnings for a permanent finance program. The 40 million (30 million plus the 10 million "matched" funds) is a 17 million dollar increase over the 1971 budget (JCET News, 1971, p).

12. Recent technological developments permit video tape recorders to respond to a specially coded address signal transmitted over the aural channel of a television broadcast. Thus live programs to be taped for later viewing may be specified. This permits greater instructional timing flexibilities.

2. Applications. To date, most applications of ETV, as here defined, have centered around the medium's abilities to bring cultural-educational programming to the general public. School systems, for the most part, have utilized these programs sparingly as an adjunct or enrichment to their own televised instruction, or as an occasional supplement or alternative to their other non-television instructional programs. A recent breakdown of ETV station ownership shows (Committee on Telecommunications Technology, 1971):

State or local authorities	43
School systems	22
State boards of education	17
Nonprofit community corporations	53
Universities	59
Total ETV stations	194

Increasingly, the distinction and competition between public open-broadcast ETV, and closed circuit instructional television (ITV), is fading as new technologies and program patterns evolve. Sesame Street is an example of a program format oriented to a general public of pre-school youngsters, that is highly applicable to in-school classroom learning goals and situations.

3. Evaluation. Public ETV is gaining wider financial support and is reaching an increased number of American homes. Recent and projected telecommunications technology developments indicate continued growth and flexibility for public ETV. A traditional rift between ETV and ITV proponents is beginning to disappear.

As found in the evaluation design of Sesame Street and in several recent (Adams, 1971; Natalicio and Williams, 1971) field evaluations of ETV programs, the trend is toward assessing a program in terms of its achievement of objectives in audience behavior. That is, like the strategy of using behavioral objectives in curriculum planning, each program has specifically defined audiences and behavioral objectives. Evaluation, then, is focused upon these objectives. This strategy provides one answer to the problem of accountability in gauging financing relative to the impact of ETV.

3.1 Educational implications of public educational television may be summarized as follows:

1. The satellite, cable television, Instructional Fixed Television Service (ITFS) in the 2500-2690 MHz band, videotape recorders, and other technological developments suggest an increased ability for the educator to define his audience, select from a wide array of program options, create interactive learning response, and evaluate the educational results of utilizing public ETV.
2. These possibilities will require and provide a flexibility of financing arrangements that are not now evident.
3. Greater use of ETV could create "schools-without-walls." Such "schools" would have their own communities, remote locations, and distant information sources as alternative learning environments.
4. Control and creation of specific instructional content will be shared by the teacher and a host of other professional people.
5. Instructional timing flexibilities, inherent in telecommunications technology,

can result in both scheduling problems and opportunities.

6. Public television implicitly recognizes the need for continuing adult education. The schools may be more active in this sphere through use of public television.
7. The school can become a more interactive community institution.

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B. CLOSED-CIRCUIT INSTRUCTIONAL TELEVISION

1. Introduction. As used in this report, the term "closed-circuit instructional television" (CCITV) refers to television programming originated and/or controlled by an educational institution and transmitted over circuits owned by the institution and/or leased from a telephone company. Thus, for example, educational programs broadcast by commercial stations or public television are excluded. Televised instruction is the primary mode in the educational use of telecommunications. Comments about the software elements of CCITV, the most common form of televised telecommunications, are applicable to all configurations of television. Therefore, these elements are discussed in greater detail under this topic than they are in the other topics in this chapter.

CCITV may serve one school, one school system, or a number of schools and systems on a state-wide basis. It may distribute its programming over coaxial cable and/or by microwave (both are restricted point-to-point transmission systems; cable uses lines, microwave uses over-the-air signals). Instructional Television Fixed Service (ITFS) in the 2500-2690 MHz band and cable television are closed-circuit transmission systems with unique operating characteristics. Both systems are discussed separately elsewhere in this report and will be mentioned here only as they relate to CCITV. The basic elements of a CCITV system are:

1. Program origination facilities which may includ

studio hardware such as television cameras, monitors, audio and lighting gear, film projectors, video tape recorders, etc., and necessary program supervisory and creative personnel.

2. Transmission equipment which may include a transmitter, transmitting antenna, coaxial cables, telephone lines, and an audio-video modulator.

3. Reception equipment which may include a receiving antenna (for microwave), and telephone lines distributing the signal to classroom television receivers.

A system may utilize monochrome and/or color equipment. Transmission band width (the difference, expressed in number of cycles per second, between the highest and lowest transmission frequencies) is limited to 6MHz (4.5 MHz for video, 1.5MHz for audio) by U.S. broadcast standards (EPIE, 1971).

Coaxial cable transmission systems may be classified as 1. video systems, and 2. radio frequency (RF) systems. In video systems, raw picture signals are transmitted as they leave the studio. The associated audio signals are usually sent over a pair of regular telephone lines. This system is good where transmission distances are short and high picture quality is required. It is not practical for large systems because (EPIE, 1971):

1. The cable can only transmit one program at

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a time.

2. The audio and video equipment required is expensive.

The RF system utilizes an audio-video modulator which converts the originating signal for transmission over radio frequencies.

> The modulator is a small transmitter that sends the picture and sound signals over a coaxial cable on one of the standard VHF channels. Since several RF signals can be carried on one coaxial cable it is possible to broadcast simulatneously on several channels (EPIE, 1971, p. 18).

Instructional television began in the late 1940s. Initial program broadcasts were made in cooperation with commercial television stations. Alabama established the first statewide educational television network in 1952. In 1958 the NBC network aired its Continental Classroom on a national basis. This limited commercial exposure was augmented by broadcasts over educational television channels beginning in the mid 1950s. By the late 1950s broadcast educational television was becoming less effective for educators because 1. program content and quality were difficult to control and specify and 2. the channel space available in the standard VHF-UHF frequencies was limited. These deficiencies prompted construction of closed-circuit instructional television systems in the nation's school districts and universities. Also, the FCC took steps to alleviate the problem of limited broadcast channel capacity when in 1963 it allocated on a trial basis the 2500-2690 MH_z frequency band to Instructional Television Fixed Service. Educators have just recently begun to utilize ITFS.

The Ford Foundation and the Fund for the Advancement of Education sponsored many CCITV applications such as the Hagerstown project in Washington County, Maryland, and the Chelsea project in a New York City ghetto. Since then additional support has been provided by local and state governments. The Educational Television Facilities Act of 1962 and the Higher Education Act of 1965 (and amendments) have provided federal support for CCITV. Initial expectations that ITV would generate significantly higher learning gains has not been generally confirmed by research evaluation. Learning progress, when comparing television to standard lecture methods, is about equal. Such findings are influenced by two factors: 1. totally reliable and comprehensive research methods have not consistently been applied and 2. traditional classroom instructional methods have too often guided the format on the televised instruction. A recurring basic criticism lodged by students has been the lack of timely student-teacher interaction in televised instruction.

Today, the number of CCITV systems is difficult to estimate as they are not regulated by the FCC. Estimates in the early 1960s ranged from 200-500 systems. Television applications to education are continuing to increase. One indication of this growth is the increase in ITFS systems from 65 in 1969 (EPIE, 1971) to 126 in March, 1971 (JCET News, 1971, f). Even so, instructional television hours account for less than three percent of total instruction time in secondary and elementary schools in the nation's 16 largest cities

(Commission on Instructional Technology, 1970). At the university level, Michigan State, one of the largest users of CCITV, covers 13.3 percent of freshman and sophomore credit hours via television (Commission on Instructional Technology, 1970).

1.1 Current developments, both technological, and non-technological, include:

1. The introduction of relatively low-cost, easy to use video tape recorders (VTR) has provided increased flexibility in program format, exchange, and scheduling. Also, VTR has made it easier for more teachers, administrators, and students to become involved in the process of creating instructional television programs.

2. Recent decisions by the FCC and the World Administrative Radio Conference on Space Telecommunications (WARC/ST) reserve channels in the 2500-2690MHz frequency range for educational and public service. These channels available to ITFS systems alleviate crowding in over-the-air transmission. Technological developments in broadcast, as distinct from relay, satellites provide additional possibilities for

audience selection.

3. Developments in cable television technology such as increased cable channel carrying capacity and provision for two-way voice communication can overcome some of the depersonalization, due to lack of student-teacher feedback, associated with CCITV.
4. Developments in information retrieval systems and networks make possible almost instantaneous student access to stored video tape programs, as well as audio, film, and printed displays.
5. Public educational television stations are increasing in number. Program distribution is becoming more pervasive due to growth in the National Educational Television network and importation of NET signals by local cable television systems. Also, there is increased emphasis on local program origination which gives additional program and coverage options.
6. Costs of developing high-quality programs for instructional television are increasing. The increase is due to employment of professional assistants in the creation

of such programs.

7. The growth in community colleges catering to a wide range of students interested in education relevant to immediate social and economic needs makes instructional flexibilities a necessary requirement, one that television may be able to help meet.
8. Regional instructional research and development centers, and national interests, both public and private, are engaged in improving the quality of televised instruction.
9. Recent FCC rulings clear the way for at least two national microwave systems to be operated by special service common carrier companies. These companies have proposed user options for time sharing of their facilities and services. "It might thus be possible for a state-wide TV network and an interuniversity computer consortium to time-share the same inter-city links at reduced costs for each, an option not now available" (JCET News, 1971, f, p.10).
10. Increased emphasis is being placed on catering to the needs of the individual

learner, who needs to become
a more active participant in creating
learning environments.

2. Applications. Generally speaking, instructional television has been used to produce, distribute, receive, and evaluate remote electronic video instructional programs. This has primarily taken the form of televised lectures to large groups of college and university students. Production of instruction has been done primarily by local personnel untrained in electronic media. Some current applications of CCITV include (NAEB,1970):

1. Magnification and visual display of laboratory materials, printed matter, artifacts, etc.
2. Behavioral observation involving skill development in counseling, teaching, and athletics.
3. An alternative means of film or slide distribution.
4. Administrative briefings on various policies.
5. Materials for drill exercise, language training, and calisthenics, for example.
6. Information storage and retrieval.
7. Presenting testing materials, particularly those requiring visual response such as identification of biological specimens.
8. Television as an element in a multi-media learning carrel.

9. Slow-scan presentation of still images.
10. Topics for scheduled class discussion and writing assignments.
11. Visual surveillance.
12. Programs for individual student enrichment.
13. Television as an element in adult correspondence courses.
14. Programmed televised instruction keyed to tightly sequenced steps directed toward specified student behavioral learning goals.

2.1 Televised instruction was initially a means of multiplying a standard lecture, or demonstration to overcome the shortage of teachers during the late 1950s and through the 1960s. Though comparatively as effective as the live lectures televised lectures failed to utilize the medium to its best advantage. Today a number of recognized problems and potential solutions are being discussed and pursued. Some of these are:

1. Teacher role
   a. After exposure to ITV, teacher fears rapidly disappear, but their original expectations with respect to ITV's effectiveness diminish (Guba, 1965).
   b. Point a. reflects the teacher's lack of training in use of the medium and lack of support required for instructional preparation and presentation.
   c. Television stresses the teacher's

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ability as an active communicating personality and not merely as a dispenser of factsand concepts. Factors of dress, speech, facial expression, and body movement are all important.

d. Television instructional workshops are being used to increase the teacher's effectiveness. The immediate playback capabilities of video tape plays an important role here.

e. Related to point d. are trends in increased use of specialists in instructional media and curriculum development to aid the teacher.

2. Instructional materials

a. Increased emphasis is being given to the fluid, dynamic nature of the medium. Presentations demonstrating a process are naturally adapted to television.

b. The student's non-school exposure to the medium conditions his expectations about its use. Shorter, faster paced instructional modules take advantage of this.

c. The "at-present," "you-are-there" aspect of television is being used to bring live remote events to the classroom.

d. Increased program content variety and scheduling flexibilities enable more individualized student instruction to take place.

e. The ideas of designing instruction to meet behaviorally defined learning goals and evaluating (validating) instruction in light of its success in achieving these goals, are being given consideration.

f. Programmed television, designed to meet the criteria of individualized instruction, has three basic requirements: 1. Self-pacing; 2. Student-teacher feedback; and 3. Monitoring (evaluating) student response (Gryde, 1966).

3. Other considerations

a. Classroom environments are being designed with greater flexibility and consideration for the mode of instructional presentation (Green, 1966).

b. Independent professional engineering consultants are being used to help plan for ITV systems.

c. Faculty-administration co-involvement in use of ITV is increasing.

2.2 Two Texas applications of CCITV are the Texas Educational Microwave Project (TEMP), and The Association for Graduate Education and Research of North Texas (TAGER). Both use point-to-point microwave transmission.

TEMP was established as an experiment in 1961 through funds provided by the U.S. Office of Education, the Ford Foundation, and contributions from member schools. Now, funds are supplied by member schools. TEMP's offices and studios are on The University of Texas, Austin campus. Programs are taped for transmission over four microwave links to 11 colleges and universities in Austin, San Antonio, San Marcos, Seguin, and Georgetown, Texas. At first, entire courses were provided over TEMP, but now the emphasis has shifted to using television as a supplemental means of instruction. Administration and faculty at all the schools participate in all phases of TEMP's operation. The faculty members are given prime responsibility over program format and utilization. An experiment in "live" instructional presentation and student feedback, utilizing telephone lines, has recently been initiated.

TAGER, a nonprofit educational organization located in the Dallas-Fort Worth metropolitan area, was established in 1965. Its purpose is to share the educational resources of area colleges, universities, and large industrial organizations such as Texas Instruments and Bell Helicopter. The cooperative effort has served over 13,000 students and presented more than 600 courses. The system uses two-way microwave transmission between all locations for its primarily live broadcasts, thus enabling students and professors immediate feedback. TAGER has expanded its original program format, directed primarily to graduate students in engineering and science, to include undergraduate students and liberal arts courses. The system is funded by member institutions, student fees ($100 per credit hour enrolled--audit fee is $50 per course), and a private foundation.

3. Evaluation. Closed-circuit instructional television remains the primary application of television and telecommunications technology to educational instruction. CCITV, though applied with little thought to its inherent characteristics, has proven to be as effective as live classroom lectures. Recent recognition of this fact, coupled with technological developments, points to possibilities in growth for the medium both qualitatively and quantitatively.

3.1 Costs for CCITV, based on hypothetical models developed by General Learning Corporation (1968), as compared with Instructional Fixed Television Service (ITFS), and VHF TV, show the following:

Annual Costs per Student

	Local	City	Metro	State	Regional
CCITV	$ 33	$ 12	$ 11	$ 11	$ 12
ITFS	31	11	11	9	8
VHF TV	41	12	11	10	9

CCITV compares favorably with the other systems for local application, is about equal for city and metropolitan applications, and more expensive for state and regional applications. Overall, in general, economics of scale operate in all systems. Production costs in particular decrease as the size of the audience increases. The Commission on Instructional Technology (1970) discloses average installation cost for a CCITV system is $178,000 and annual operating cost is $86,000. Program costs can range from $50 to $6,000 an hour.

3.2 Educational implications may be summarized as follows:

1. Successful use of CCITV requires a complete rethinking of what instructional strategies, and in a larger sense, learning environments, consist of. The full potential of televised instruction has been primarily thought of as a way to simultaneously deliver the standard classroom lecture to a large number of students.
2. Teachers, generally, have not been adequately trained as television instructors, and they have not been provided with coordinated support from professional medium and curriculum specialists.
3. Recognizing the efficacy of the above, educators are giving increased attention

to the creation and distribution of high-quality television programs, and are providing teachers with needed training and support.

4. To accomplish the goals in point 3. increased emphasis is being placed on regional and national cooperative efforts and funding. This trend is beginning to blur the distinction between CCITV and ETV, such as National Educational Television.

5. Technological developments such as cable television, ITFS, satellite, and videotape are providing additional flexibilities for program selection and scheduling. Also, patterns of equipment utilization are changing to include more active participation by teachers, students, and administrators.

6. Television, though the primary educational application of telecommunications, is increasingly being used as one of a number of media available to the instructional process.

7. Rapidly changing social and economic patterns are placing increased emphasis on individualized and relevant learning.

Television has capabilities to meet these requirements. Economics of scale are attractive in light of increased citizen resistance to increased taxes.

C. INSTRUCTIONAL TELEVISION FIXED SERVICE

1. Introduction. Instructional Television Fixed Service (ITFS), established by the FCC in 1963, is a cross between closed circuit and over-the-air television systems. Over-the-air transmission takes place in any of the 31 channels allocated to education and public service by the FCC in the frequency band 2500-2690 MHz. Reception is restricted to locations designated by the system operator and equipped to receive the ITFS signal.

1.1 FCC actions. The Commission established that each ITFS licensee could use up to four channels. This is feasible because the low power signal transmitters (one is required for each channel) have a limited range that restricts interference with other broadcasting frequencies, or even with another ITFS system in a nearby town. The allocation was provisional with the FCC reserving the right, after two years, to review the educators' use of the frequency band. The relatively small response by educators combined with pressures from commercial interests prompted the FCC to propose designating three of the 31 channels for industry and business. Based on objections lodged by the Joint Council on Educational Telecommunications (JCET) and others, and

> ...noting the development of a proposed intergovernmental, multi-point, two-way system on the H-channels [i.e., the three channels intended for business and industry] in the Greater New York area, (the FCC) decided to make the H-group available primarily for such noncommercial public service uses as New York's Metropolitan Regional Council has planned. (JCET News, 1971, h)

Business and industry will have access to these three remaining channels, but only after municipal public service demands have been met. Additionally the FCC has required that all new entrants to the frequency band must meet technical specifications identical to those of the educators. This requirement has particular relevance to future use of satellites by education because it provides incentive for commercial users to modify their terrestrial systems "in order to meet the needs of the educational satellite service" (JCET News, 1971 h).

An added note concerning allocation of the 2500-2690 MHz frequency band has international repercussions. In a recent meeting in Geneva, Switzerland, the World Administrative Radio Conference on Space Telecommunications (WARC/ST), a United Nations organization, adopted a ruling similar to the FCC's that is binding on its almost 150 members who represent Communist Bloc, Third World and Western interests.

> What the WARC/ST decision means in non-technical terms is that the way is now clear for the development of satellites to serve this country and any other nation in the world with sufficient power to bring ETV and other services to any spot equipped with a satellite receiving terminal at very modest cost (JCET News, 1971, u).

1.2 System components (Birmingham, 1971).

1. Program originating equipment consists of studio hardware such as television cameras, monitors, audio and lighting gear, film projectors, videotape recorders, etc.

2. <u>Transmitting equipment</u> consists of the transmitter itself and transmitting antenna.

   A. Transmitter. The transmitter is low power (10 watt maximum), generates signals in the 2500-2690 MHz frequency band, and overlays on this signal the audio and video signals originating from the studio.

   B. Antenna. The transmitting antenna is either uni-directional or multi-directional, depending on the topography of the area to be covered. It can transmit up to four channel frequencies at once.

3. <u>Receiving equipment</u> consists of the receiving antenna, converter, internal distribution system, and classroom receiver.

   A. Receiving antenna. Each receiving location has a rooftop antenna designed to bring in a sufficient signal for the receiving equipment.

   B. Converter. Signals in the 2500-2690 MHz frequency band are microwave signals. The ITFS converter transforms these signals to a standard VHF frequency. It can accept and convert up to four different frequency channels at once.

C. Internal distribution system. The "converted" signal is carried, by coaxial cable, from the converter to the classroom. The internal distribution by coaxial cable requires only one antenna and converter per location, and it may be used to carry a closed circuit signal originating within the building.

D. Classroom receiver. A regular television set receives the ITFS signal.

2. System Applications. Through October, 1969, based on an Educational Products Information Exchange (EPIE) survey published in 1971, there were 65 ITFS systems with 152 channels operated by 39 school districts (out of a nationwide estimate of 15,000) in 21 states. Twenty of these 39 districts were located in New York or California. Approximately 1.7 million students were served. At that time 14 more ITFS permits had been granted by the FCC for facilities to be constructed. More recently JCET News (1971, 1) reports that approximately 126 systems with 378 channels are serving about 8,000 schools with approximately five million students. Forty-six systems with 138 channels had outstanding construction permits at that time. Individual systems vary in size and cost. The following discussion of a particular ITFS system is based on a November, 1967 article in Audiovisual Instruction magazine, and information

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presented in the 1971 EPIE survey.

2.1 The Pasadena, California system. The Pasadena School District in the early 1960's decided to use television as the primary instructional instrument to teach foreign language to its elementary school students. As involvement with television increased, a decision was made to establish a four-channel ITFS system. The four-channel ITFS system was chosen for two major reasons: 1. It permitted greater time scheduling flexibility; and 2. The hilly terrain created transmission and reception problems for other types of systems. An additional incentive was availability of quality program interchange through the Regional Television Advisory Council (RETAC) representing approximately 100 school districts in southern California. A private consulting engineer worked with a general electrical engineering firm to design the system, prepare the specifications, and advise on purchasing of equipment and awarding of bids. He continues to advise the school system. The following goals, established at system inception, indicate the school district's expectations of what ITFS could accomplish (Fink, 1967, p. 927).

Goal 1-- To provide uniformly good, clear reception in all schools.

Goal 2-- To develop new patterns of local organization for producing and utilizing ITV and other related programs.

Goal 3-- To schedule and reschedule existing programs.

Goal 4-- To extend the facilities and resources of the Learning Materials Center.

Goal 5-- To develop in-service programs.

Goal 6-- To improve communications.

Goal 7-- To explore new areas for ITV, including use in secondary schools.

Goal 8-- To share with other community agencies, both public and private.

Reviewing these goals a number of concepts emerge.

1. Successful utilization of ITFS, as with other media applications, requires active participation by teachers and administrators in the creation of instructional presentations and curriculum development. This suggests an increased dynamic element in traditional roles.

2. An increased dynamic element also inheres in the greater time flexibility provided by the ITFS system.

3. In conjunction with the other RETAC members, program quality and diversity should improve and cost less per student served.

4. Use of other media, through the Learning Materials Center, will modify concepts of what the various media, singly and in concert, are designed to do.

5. ITFS, as can be seen in other telecommunication systems, may be used in a multiplicity of learning situations.

6. The ITFS system, as do other telecommunication systems, has the potential for a

wider range of school-community interaction than previously possible.

The Pasadena system, operating 100 hours per week, covers a radius of six miles and serves approximately 20,000 students in 34 school buildings. There are 350 classroom receiving sets and two studios, one stationary, one mobile. The installation cost was $420,000; $120,000 provided by federal government, the remaining $300,000 provided by local government. Annual operating cost is $50,000, although it is not clear if this includes salaries for five full time and twenty-four part time employees (EPIE, Instructional television, 1970). Again, though Pasadena's application is not discussed as a typical ITFS system it serves to indicate rationale and approximate costs.

3. Evaluation. ITFS, though beginning to show growth, is not yet a major application of telecommunications technology to education. The present hesitancy is due primarily to a lack of feel for how other developments, most notably cable television, are going to relate to ITFS.

3.1 Costs of ITFS, in comparison with UHF and CCTV systems, are about equal for production, less expensive for distribution, and more expensive for reception (General Learning Corp., 1968). Overall, ITFS appears to be relatively more economical in small school district applications and about even in larger city, state, or regional networks. Looking at the Pasadena example above, the yearly student cost, exclusive of capital depreciation, is $2.50 ($50,000 operating cost divided by 20,000 students). Data are not available to determine cost per student/hour of ITFS programming.

3.2 <u>Educational implications</u> of ITFS may be summarized as follows:

1. ITFS multi-channel capability, provided for by the FCC, allows program timing flexibilities.
2. Voice and data, as well as video transmissions are available so that multimedia presentations are possible.
3. Experimentation by television, due to relaxed FCC broadcasting specifications, is a real prospect.
4. With the converter, standard VHF-UHF receivers may be used. Thus, such receivers may function as part of different systems.
5. ITFS, as an essentially private system, allows local educators control over instructional programming.
6. The low power output of ITFS transmitters permits the allocation of the same channels to many different though nearby locations.
7. As with other television systems, instructional quality and learning progress depend heavily on the programming. This in turn requires trained personnel.
8. Point 7 also implies that, for most school

systems, access to programming through state, regional, or national cooperative groups, is vital.

9. FCC provision for voice response in the frequency band 2686-2690 MHz makes student-teacher feedback possible (FCC, 1970).

D. VIDEO TAPE RECORDING--VIDEO CASSETTES

1. Introduction. Video tape recording (VTR) is a fast growing area in use of telecommunications in education. VTR is considered an aspect of telecommunications because of its close relation to, and extensive use in, television systems. It is considered separate from other television systems because of its unique aspects of relatively low cost, instantaneous replay, and portability. VTR, in some cases, is used as a complete television production, transmission, and reception system.

1.1 Video tape recorder as a term refers to a system of recording and playing back visual images on electromagnetic tape. The three basic components of the system are the video camera, the video recorder-play back, and the video display. The most convenient way to classify the diversity of portable VTR systems and components available is on a basis of video tape format. The three classifications are (Tettem er & Stowers, 1969):

1. Broadcast Adaptable. Every model, regardless of format, is included in this category if it meets broadcast standards established by industry and government.
2. 1" Tape Format. These models use 1" (width) tape and vary in price depending on what features such as color, editing, recording and play back, they offer.

3. ½" Tape Format. These are the smallest and generally least expensive systems. They are portable and may or may not have battery power-packs.

All the recorders in the above classifications are helical scan recorders. This means that images are recorded slant-wise across the tape in distinction to a quadruplex recorder that records images in a transverse direction across the tape (i.e. 90 degrees to the direction of the tape). The quadruplex system uses a two inch tape, but is not portable. Cameras may include such features as a zoom lens and electronic viewfinder. The viewfinder permits instant replay viewing through a small built-in screen. Television receivers specially equipped to monitor direct video tape input may vary in screen size and be either monochrome or color. These receivers also get all the standard VHF-UHF channels and may be used with a variety of telecommunication systems.

1.2 Video cassette is a term used to cover a number of different technological approaches to the idea of recording and/or viewing a tape or disc that is enclosed in a cassette or cartridge similar to those used for audio tapes. Tapes vary in width from 8.75 mm to 3/4" and in material from standard polyester to holographically embossed vinyl. These systems fit into two general classifications: 1. those that record and playback; and 2. those that provide only playback capability (Berger, 1970). The playback-only systems include

Columbia Broadcasting System's (CBS), Electronic Video Recording (EVR) and RCA's Selectra Vision which uses a holographic, embossed vinyl tape. Both blank and pre-recorded tapes carry audio and video tracks and may be played back through a standard television receiver equipped with an appropriate converter-play back device. At this time only CBS-EVR is being marketed at a price of $700-800, and only to educational and industrial interests. Two major problems exist with cassette systems: 1. lack of standards resulting in cross-system incompatibility of tapes, and 2. relative unavailability of pre-recorded programs. Cost, because of low volume, is high for blank and pre-recorded tapes (a survey of pre-recorded EVR tapes currently available indicates a price range from about $30 to $250), and the question of copyrights and royalties is not yet resolved. Because of the recent introduction of these systems, user feedback is not available and so discussion of applications is not possible.

2. Applications. The uses of VTR are almost limitless. Tettemer and Stowers (1969, p.9) in their survey of VTR users came up with the following applications ranked by frequency (see Table 1, next page).

Table 1 indicates a number of trends:

1. The non-broadcast models are used primarily for instant playback (e.g. feedback).
2. The broadcast adaptable and 1" models are used about equally for closed circuit distribution and recording for future use.

TABLE I

PRIMARY USES

USE RANK	BROADCAST ADAPTABLE	1" MID-RANGE	1" LOW PRICE	½" PORTABLE	½" BATTERY POWERED
1	Recording for Future Use	Instant Playback	Instant Playback	Instant Playback	Instant Playback
2	Closed-Circuit Distribution	Recording for Future Use	Closed-Circuit Distribution	Recording for Future Use	Record Data, Tests, Etc.
3	Instant Playback	Closed-Circuit Distribution	Recording for Future Use	Off-Air Recording	Recording for Future Use
4	Off-Air Recording	Off-Air Recording	Playback of Exchanged Tapes	Record Data, Tests, Etc.	—
5	Playback of Exchanged Tapes	Playback of Exchanged Tapes	Off-Air Recording	Closed-Circuit Distribution	—

3. Playback of exchanged tapes takes place with relative infrequency and only on the larger machines.

The above chart, though useful, does not indicate the diversity of individual VTR applications. Some of these are:

1. In-service teacher training and evaluation (most notably the Stanford Micro-teaching program, Bureau of Research, 1968);
2. Converting film to videotape;
3. Recording speech therapy sessions;
4. Critiquing music and drama performances;
5. Recording surgical operations for medical students;
6. Recording group therapy sessions;
7. Use in audiovisual carrels;
8. Student creation of tapes as a means of artistic expression;
9. Recording school sports events for later viewing by coaches and teams;
10. Recording current news events "live" or from broadcast television;
11. Recording motorist actions for driver education; and
12. Recording of on-the-job vocational skills for student viewing.

Some schools buy the small, portable systems and occasionally lease larger systems to record and reproduce tapes for broad-

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casting and/or interchange with other schools and school systems. Too, some school districts have outfitted small vans with VTR equipment so that, in effect, they have a mobile video studio.

3. Evaluation. Educators have taken to VTR more readily and enthusiastically than any other telecommunications medium (JCET News, March 1971, shows 26 percent of the nation's schools have VTR equipment). In most cases their initial enthusiasm has been subsequently realized. Most have been satisfied with performance of the portable VTR's, but have expressed some dissatisfaction with machine reliability and service provided by manufacturers and distributors (Tettemer and Stowers, 1969).

> This problem of interchangeability is perhaps the worst in the whole area of VTR's. There are also no industry standards for basics such as horizontal resolution...and, most important, maintenance and technical training for new users in the field. (EPIE, 1969, Introduction to, p.3).

Since the EPIE report, a number of industrial and engineering groups have begun defining standards, but, as was the case with audio tape, the market place will probably be the final arbiter.

3.1 Costs vary with the format of the system and the size of the school district. Total annual production, distribution, and reception cost per student has been estimated at $65 (General Learning Corporation, 1968). This estimate, made for a local (small) school district in 1968, seems high in light of recent price reductions for VTR equipment. For example Sony sells a school package, consisting of a record-playback device, two video cameras with electric viewfinders, various accessories including microphones and a portable battery pack, for approximately $4,000. A black and white video receiver costs as little as $200. Tape sufficient to record an hour of monochrome and a half hour of color programming costs about $40. Therefore assuming 500 students in a school, and full equipment depreciation, annual costs per student would be slightly more than $8. Production costs would vary with quality and quantity. An indication of equipment costs in terms of tape format classification are (Tettem er and Stowers, 1969):

1. Broadcast Adaptable--$9,000-16,000.
2. 1" Tape Format--$1,000-6,000.
3. 1/2" Tape Format--$700-1,500.

3.2 Educational implications are directly related to the nature of the VTR medium. Characteristics of the medium are:

1. Almost instantaneous lifelike recording and playback of audio and visual modes;
2. On-the-spot portability;
3. Relative economy;
4. Relative ease of use;
5. Ability to record a diversity of "subjects;" and
6. Rapidly changing technology.

The educational implications of these characteristics, and other points discussed are:

1. Teachers, administrators and students may have access to and successfully use VTR.

2. Larger, more expensive equipment is necessary to produce broadcast (and hence interchangeable) quality tapes.

3. From point 2 and considering the present diversity of machine configurations, VTR tape interchange may be fairly difficult between school systems.

4. Instructional situations involving physical drill or presentation, from teacher-student interaction to cheer-leading, are naturals for VTR use.

5. Instructional time can become increasingly flexible. Lectures or demonstrations, for example, may be recorded and available at a "library" for the student to use when he wishes.

6. Choice in purchasing a particular VTR system, due to the many available, must be systematic.

7. The impact of VTR on the use of other audio-visual devices, such as the movie camera/projector, should be considered.

8. As yet, questions of copyright and royalties, though legally unsettled, must be considered.

9. Video cassette use, due to its recent introduction, is not evaluated. However,

pre-recorded tape prices are high and not likely to be reduced until technological breakthroughs in production are achieved and wider distribution takes place.

E. SATELLITE

1. Introduction. Communications satellites are high altitude signal relay devices that can provide coverage for a large geographical area. There are three basic satellite types: 1. relay satellites, 2. distribution satellites, and 3. broadcast satellites. The basis for this classification is effective signal radiating power. Generally, increases in satellite power make possible reductions in power and cost of terrestrial receiving equipment. The first commercial communications satellite, the Early Bird, with a capacity of 240 telephone circuits was placed into orbit in 1965. Since then, (as of March, 1971), seven more satellites have been placed into orbit increasing total transmission capacity to approximately 13,000 telephone circuits (Communications Satellite Corporation, Pocket guide, 1971). Placing the satellite in orbit 22,300 miles above the equator permits its period of rotation to be synchronized to that of the earth's. The satellite appears to stand still. The syncronous orbit, possible only in the equatorial plane, is advantageous because it permits coverage of one third of the earth's surface by one satellite, and allows stationary rather than movable earth station antennae.

Early in 1971 over 50 earth stations operating in about 30 countries comprised a global system (COMSAT, Pocket guide, 1971). Earth terminals may be either one-way (receive only) or two-way (send-and-receive), consist of one or more radar-like antennae 25 feet or more in diameter, and serve users in a designated geographic area (Norwood, 1969). The following steps are typical of the path for a "Via Satellite" television relay (Norwood, 1969, p. 97):

1. Program originates in the television studio, and
2. The signal is sent via common carrier or other conventional land lines to
3. A satellite earth terminal capable of transmission, from which
4. It is sent to a communications satellite 22,300 miles above the equator, which
5. Retransmits the signal to one or more receiving earth stations, which send it along
6. Via common carrier to other land lines, to
7. Conventional TV stations, which retransmit it for
8. Reception by conventional TV sets in offices, homes, and classrooms.

Today satellite systems use either full-time dedicated (i.e., private) channels between two points, or multi-destination channels. Both dedicated and multi-destination channels are pre-assigned between any two points in the system. This arrangement causes certain traffic handling inefficiencies which will soon be overcome. Satellite systems in 1970 achieved a 99+ percent reliability rate.

Redundancy, or alternate routing capabilities, is improved due to technological refinements such as dual antennas and spare capacity (COMSAT, Report to, 1971). Satellites can carry any kind of information that is capable of being electronically transmitted. Telephone transmission currently accounts

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for about 79 percent of total communication satellite traffic (COMSAT, Report to, 1971).

1.1 COMSAT and INTELSAT stand for Communications Satellite Corporation (the U.S. member) and the International Telecommunications Satellite Consortium. In 1962 Congress enacted the "Communications Satellite Act" providing for creation of a publicly held U.S. Corporation (COMSAT) that would establish, in cooperation with other nations, a world-wide communications satellite system. In 1964 an international joint venture, INTELSAT, was formed. The original 14 members have grown to 80. Since inception COMSAT has controlled more than 50 percent of the INTELS AT votes. Recent negotiations have reduced the current U.S. role to 40 percent with further reductions planned for the future (JCET News, 1971, k).

1.2 Current developments, both technological and non-technological, include:

1. The World Administrative Radio Conference on Space Telecommunications (WARC/ST) recently reached agreement on allocating frequencies in the 2500-2690 MHz band to the Broadcasting Satellite Service for community reception. This would allow use of high power satellites for ETV transmission to low cost earth receiving terminals (JCET News, 1971, u).
2. An experiment sponsored by HEW, utilizing

a NASA Application Technology Satellite (ATS-1), begins this fall; its purpose is to bring two-way voice communication of educational and community services from outside expert sources to 21 remote Alaskan villages (JCET News, 1971, n).

3. National Public Radio, a counterpart of NET, may try broadcasting its educational programs to Alaska via the ATS-1 satellite mentioned in point 2 (JCET News, 1971, n).

4. HEW and the Corporation for Public Broadcasting (CPB) in cooperation with NASA will begin experimental educational and health programming, by ATS-F satellite, to remote Rocky Mountain and Alaskan areas, in September, 1973 (JCET News, 1971, c).

5. The programs in point 4 are designed to test low cost earth receivers and 2500-2690 MHz (ITFS) transmitters aboard the satellite.

6. A number of U.S. commercial interests have proposals before the FCC for creation of a domestic satellite system. Some mention has been made of providing circuits for ETV, but no cost considerations have been set (JCET News, 1971, b).

2. Applications. To date there have been no consist-

ently scheduled applications of satellite technology to education. For a number of years India has considered establishing a nation-wide system of ETV via satellite, but cost problems and political considerations have, to date, prevented development of this system. A Broadcasters' Non-Profit Satellite Corporation (BNSC), proposed by the Ford Foundation in 1968, providing for satellite-ETV station interconnection and financial support for the Corporation for Public Broadcasting (CPB), has yet to materialize.

> While instructional television service could be provided by such a BNS system, the chief aim of the proposal is to strengthen public broadcasting (Norwood, 1969, p. 99).

In June, 1967, a two-hour worldwide program, originating in 14 nations and covering such diverse topics as the birth of a baby in Mexico to canoeing in Sweden, was shown via satellite (National Educational Television, 1967).

3. Evaluation. At present satellite telecommunications have had relatively little impact on education. The reasons for this have been largely economic, and for international applications, diplomatic. Recent and projected technological developments such as high-power broadcast satellites and low cost earth receivers point to a change in this picture.

3.1 Costs to date were mainly hypothetical. Three modeled propositions give the following cost comparisons (Meaney, 1968):

INITIAL INVESTMENT
and
10 year operating cost

	Broadcast Satellite	Ground Microwave
1. Community/ Distribution Satellite for India:	$ 87,000,000	$ 150,000,000
2. Direct Broadcast to Alaska	$155,000,000	$ 320,000,000
3. ITV Satellite for U.S. (Inclu. Hawaii and Alaska):	$195,000,000	$1,285,000,000

In all applications, satellite systems have an apparent advantage, but it must be remembered that these projections made three years ago in 1968, were hypothetical. General Learning Corporation (1968) projected approximate annual per student costs for a regional model covering 550,000 square miles with a total population of 42,000,000. "There are 10,000,000 students in 9200 elementary and 3100 secondary schools" (General Learning Corp., 1968, p. 72).

	ITFS	SATELLITE-TV	UHF-TV	CCTV
Production	$ .50	$ .50	$ .50	$ .50
Distribution	1.50	2.00	4.00	7.00
Reception	6.00	5.00	5.50	5.25
Total	$8.00	$7.50	$10.00	$12.75

The report did not project satellite costs for smaller local and

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metropolitan models. "COMSAT has proposed a program of substantial rate reductions in the event certain conditions are met that would favor short-term and long-term growth in satellite traffic and revenues" (COMSAT, Report to, 1971, p. 21). At present, satellite transmission costs for full television service range from about $450 to $750 for the first ten minutes (COMSAT, Report to, 1971).

3.2 Educational implications may be summarized as follows:

1. Satellite Instructional Television Fixed Service (ITFS) systems, due to recent developments in national and international regulations, and up-coming technological innovations, will probably be the first to develop.
2. Such satellite broadcast systems as may develop will be, initially, economical only for regional applications.
3. Such regional systems place increased emphasis on instructional program quality and variety. This will dissolve, to some extent, the local educator's control over instruction.
4. Point 2 indicates that inter-district cooperation in planning and financing instruction will be necessary. Such planning has to be done well in advance

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of program implementation.

5. Initially, most educational satellite programming will be originated by and for NET stations.

6. Projected developments in multi-destination broadcast satellite capability point to the availability of a multitude of "global villages" for use as learning environments.

7. NASA, facing increased budgetary pressures, has stepped up its program of practical application for its space technology. Hence its satellites may be designed and utilized for more public services such as ETV.

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F. CABLE TELEVISION

1. Introduction. Cable television, or community antenna television (CATV), is a closed-circuit system consisting of: 1. A master receiving antenna (similar in principle to those used by hotels and apartment houses) and/or a microwave relay that picks up broadcast television transmissions; 2. "Headend" equipment that filters, modifies, and amplifies the received signal; and 3. A coaxial (two-way) cable that carries the signals to an ordinary home television receiver. Additionally, a local studio may originate and transmit programming over the coaxial cable. CATV, traditionally used to bring standard broadcast television service to subscribers in smaller communities, has grown rapidly in a number of ways since the first system was constructed in 1949: 1. Today, there are 2,750 CATV systems serving about 18,700,000 viewers in 4,600 communities (National Cable Television Association News, 1971) and 2. The original signal reception/transmission capacity has increased five-fold to 20 channels. All signals are converted at the "Headend" for standard VHF (channels 2 to 13) reception. Presently there is no great difficulty in putting 20 channels on cable. The problem exists with the standard VHF tuner which can detect only 12 channels. Technical difficulties also exist for receiving the additional channels of UHF tuners. Originally only franchises granted by local communities were required to establish a CATV system. Since 1965, because of its growth, pressure from broadcast interests (particularly UHF), and recent Supreme Court action, the FCC has begun to exercise control.

over CATV--thus limiting the influence of the states as regulatory bodies. A primary question is whether to define CATV as a "communications enterprise" responsible to the needs of its audience, or a common carrier, such as the Bell system which assumes no liability for the content of a client message (Singer, 1970). Presently, though FCC stance toward CATV has moderated, the final form of regulation is unsettled.

1.1 <u>Current developments</u>, both technological and non-technological, include:

1. Reflecting its growing importance in national communications President Nixon has recently established a high level administrative committee to prepare a report on the long range implications of CATV. The report is scheduled for completion toward the end of 1971.
2. Recent FCC thinking allows CATV importation of distant signals into all sizes of television markets. The number allowed varies according to the market involved. This allows, for example, more than one ETV station to be imported into a given market. Additionally, the FCC requires a CATV station to carry all signals within 35 miles of its location. This includes all ETV signals (JCET News, 1971, a).

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3. Technological development makes possible 20 or more channels and two-way communication between the "headend" and the remote location.

4. Recent FCC thinking reflecting the development in point 3 also provides that each CATV channel devoted to signal retransmission will be matched by a channel devoted to non-broadcast (i.e., total cable transmission from point of origin) public services. One channel is to be made available for each public service. Education and local government will have free access to CATV for a five year period. Educators will be guaranteed one free channel under this ruling. "Free," does not include production costs except for five-minute or less transmissions. The FCC is also considering requiring capability for two-way voice transmissions. These rules are immediately applicable to all new CATV systems to be built in the top 100 markets. Existing systems in the top 100 markets have five years to comply (JCET News, 1971, d). Some proposed public service uses include:

a. voting
b. public polling
c. shopping
d. emergency services
e. utility meter reading
f. facsimile read-out
g. free forum
h. information access/storage
i. health
j. gambling

5. A recent FCC ruling requiring CATV systems serving more than 3500 subscribers to engage in substantial program origination has been challenged in the courts. The challenge, if successful, could influence the amount of cable time available for educational purposes in small towns and rural areas especially.

6. FCC suggestions that 5 percent of CATV revenues be set aside for the National Educational Television network (NET) have met opposition from the Corporation for Public Broadcasting (CPB), NET's sponsor, because it is felt that this might reduce government funding.

7. Because of present television receiver limitations, the National Cable Television

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Association (NCTA) has proposed that a special CATV receiver be built for commercial sale. This would have a number of effects:

a. A built-in tuner would permit over 20 channel reception.

b. Channel interference would be reduced.

c. Complex over-the-air electronic equipment could be omitted.

d. Picture and sound quality would improve.

e. Television receiver prices would be reduced.

8. Satellites offer inexpensive and flexible interconnections among different CATV systems.

9. Direct message addressing will permit selection of particular receiving points to form in audience for the sender's message.

2. <u>Applications</u>. To date, other than importation of NET educational-cultural programming, cable television has not been extensively utilized in education. One system, incorporating the latest in current telecommunications technology, is undergoing evaluation. Located in Reston, Virginia, it points a way to what may be expected in the near future.

2.1 TICCIT (time-shared, interactive, computer-controlled, information television), being developed by MITRE, a non-profit corporation, under a $5,000,000 grant from the National Science Foundation, is an interactive telecommunications system consisting of three modules (Volk, 1971):

1. Home terminal--
   a. standard television receiver
   b. video tape recorder
   c. specially designed coupler/decoder
   d. standard touch-tone telephone
2. Computer facility--an array of computers and peripheral equipment designed to receive, process, store, and retrieve information.
3. Communication link--
   a. two 12-channel coaxial cables between home and cable "headend"
   b. telephone cable link from home to computer center
   c. one-way microwave relay from programming studio to master antenna and "headend"

TICCIT is tied into a Reston CATV system that carries other television and FM radio stations that will reach about 3000 homes by the end of 1971 (Volk,1971). The TICCIT system, still in the experimental design stage, has five home terminals.

Standard television transmits new picture frames 30 times per second--even for still pictures. By utilizing special devices TICCIT terminals in several hundred homes may be accomodated

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on one cable channel. These devices allow each picture frame to be transmitted to a computer-encoded home system address only once, or in 1/30 of a second. At the home terminal the picture, if properly encoded, is received, recorded, and then fed back onto the television screen at the rate of 30 times per second. The user requests service or answers messages by "tapping in" to the computer via his touchtone telephone. The computer automatically beeps a signal when it is ready for interaction. A TV screen display ofservices available is then presented to the user who depresses the appropriate number on his touchtone phone for the services he desires. Audio messages may also be programmed on the computer (Volk, 1971).

At present educational and public service programs are being developed. The first educational program, called "Carry," teaches children the rules of adding any two-digit number. Other programs are aimed at fourth-grade-level arithmetic students and include five-day drill-and-practice and pre and post-tests. Present and projected community services include weather, sports scores, stock exchange information, classified advertisements, the Reston Telephone Directory, a weekly calendar of special community events, and a weekly TV guide (Volk, 1971).

3. Evaluation. Developing channel capacity, the capability for two-way communication, and recent FCC regulatory provisions make CATV a telecommunications medium that will continue to grow throughout this decade. The implications for education are manifold, including the possibility that traditional permanent school buildings and classroom gatherings may no longer

play as substantive a role in education as they do today.

3.1 Costs at present are hypothetical because of the relative lack of current applications and the number of options for CATV utilization open to the educator. These range all the way from "free" services provided by local CATV franchises to a system such as MITRE's whose cost is, as yet, not available. (Volk, 1971, estimates future cable transmissions costs to be 10¢ per terminal/hour). Presently, most commercial cable tie-ins cost the subscriber about $5 per month. NCTA estimates the following construction costs:

1. Cable--$4,000 to $50,000 per mile depending on location--rural or urban.
2. System--in cities 250,000-500,000 from $10 to $20 million.
3. System--"average" system between $500,000 and $1,000,000.

3.2 Educational implications may be summarized as follows:

1. CATV's dual ability of combining over-the-air and closed-circuit characteristics give the educator a number of programming options.
2. Cost factors for a local school district may be attractive depending on the avail-ability of local, commercial CATV channels for "free" educational use. ("Free" is

in quotes to indicate that though transmission costs may be free, instructional, production, and receiving costs will not be).

3. Recent regulatory developments and high-level administrative interest should make CATV capacity increasingly available for educational uses. Finalization of long-range plans requires a thorough assessment of regulatory controls.
4. Frequency allocation, becoming critical because of crowded airwaves, does not restrict CATV growth.
5. Cable transmission provides better reception than over-the-air transmission.
6. The possibility of linking and unlinking CATV systems via satellite makes for flexible coverage.
7. Interactive television, such as MITRE's TICCIT, overcomes certain feedback problems and provides for program timing flexibilities. Also, audiences may be critically defined.
8. Estimates that 60 percent of American homes will be wired for cable reception by the latter part of this decade provide potential access to a great number of students (Singer, 1970).

9. Public service use of CATV, such as polling, voting, and "open forums" will have an impact on the nature of the educational process as well as other social-political institutions.

10. Possibilities exist for local school districts and potential commercial CATV franchises to cooperate and share costs in the construction of production and transmission facilities.

11. Copyright restrictions may be lifted in some cases involving transmissions of public performances to schools only.

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G. RADIO

1. Introduction. Educational radio may be broken down into three main categories: 1. FM stations controlled by educational institutions; 2. Educational programs periodically scheduled on commercial AM and FM radio; and 3. National Public Radio (NPR), a nationwide system directed by the Corporation for Public Broadcasting similar in concept to NET. This report mainly discusses the first category in detail. Although no educational applications were discovered, mobile radio will also be briefly mentioned. In all cases, except mobile radio, the three basic components of radio broadcasting are:

1. Program originating equipment consisting of various audio pickup, reproduction and amplification devices.
2. Signal transmitter and transmitting antenna.
3. Radio receiver which may or may not require an elaborate receiving antenna.

Since the first broadcast over 51 years ago, educational radio has grown to 457 stations, 432 FM and 25 AM, as of July, 1970. Nearly one-third of the total use low-power transmitters permitting a broadcast radius of two to five miles (Forsythe, 1970). Forsythe (1970) found that 75 percent of the stations were licensed to colleges or universities, 20 percent to public schools, and the rest divided among other educational organizations, libraries, and municipalities. Instructional radio broadcast to classrooms comprised about 10 or 15 percent of the programming--the rest being devoted to cultural enrichment, student training in radio, and in a few cases, teacher education.

1.1 Networks most commonly are involved in the exchange of tape-recorded programs. An example of such an educational radio network is the National Educational Radio Network (NERN), a project of the National Association of Educational Broadcasters. Also many large universities distribute taped programs most of which are cultural rather than instructional (Forsythe, 1970). Station WHA serving Wisconsin, and the Eastern Educational Radio Network with eight stations serving four states and the District of Columbia, are examples of live, interconnected, educational radio networks. Additionally there are professional two-way networks existing in several states, and a number of states are considering radio networks (Platts, 1968).

Funded in March, 1970, the NPR network began broadcasting across the nation in May, 1971 on over 90 stations. NPR, a membership organization for public radio stations, both provides and distributes programs over member stations.

1.2 Current developments, both technological and non-technological, include:

1. Multiplexing allows one or more additional signals to be transmitted in the sidebands of a main channel transmission. Stereo music broadcasting is an example of this.

2. Radio may be used in conjuction with other devices and systems such as speaker-phone and electrowriter. (These are currently used in connection with telephone lines).

3. Educasting Systems, Inc. has developed an educational radio system involving four FM subchannels. This closed-circuit system allows student response to multiple choice questions and gives the student immediate evaluation of his response. Though such a system is designed for very short distances it may be adapted to longer over-the-air broadcasting (JCET News, 1970, e).

4. Two-way radio transmission of educational and health information via satellite to remote Alaskan villages is scheduled to begin this fall. The experimental program is sponsored by Health, Education, and Welfare's Office of Education and the National Institutes of Health in cooperation with the National Aeronautics and Space Administration (JCET News, 1971, o).

5. Additionally, it has been proposed that NPR be directly linked, via satellite,

with its most distant affiliate, KVAC (FM) in Fairbanks, Alaska (JCET News, 1971, o).

6. FM transmission of slow-scan television pictures is possible. This technique involves filling the TV picture frame once every 50 seconds.

1.3 Mobile radio is used primarily for private, two-way, short-distance voice communication between a central field location and a number of moving units such as taxicabs and delivery vans. Police and fire departments make similar applications. Two-way communication may also be used between two moving units. Recent microminiaturization trends have increased the performance, convenience, and durability of mobile radios. Selective calling, though possible (mobile telephone is an example), is expensive, and the relative lack of available channels makes for traffic congestion. The FCC has recently added a fourth available frequency band, 900 MHz, to the three already existing in the 30 MHz, 150 MHz, and 450 MHz bands (Committee on Telecommunications, 1971).

2. Applications. Realization of radio's full potential has been hampered by lack of adequate funding. Over half the educational radio stations operate on budgets of less than $20,000 (Forsythe, 1970), and six-sevenths on less than $100,000 (Blakely, 1971). Forsythe (1970) mentions a number of multi-media radio applications:

1. "Radio visions" at WHA, Wisconsin uses film strips correlated with instructional radio

broadcasts of art classes.

2. WFBE, Flint, Michigan, correlates radio programs and tests distributed to students.
3. WDTR, Detroit, combines radio with television to teach English in grades four, five, and six.
4. WBOE, Cleveland, coordinates radio with colored slides for fifth and sixth grade art programs.
5. KLON, Long Beach, California, broadcasts radio language arts programs coordinated with picture books distributed to kindergarten students.
6. Albany Medical College's radio broadcasts over WAMC is an example of professional programming using combinations of FM multiplex channels, telephone or broadcast talk-back arrangements, and coordinated visual materials.

Great Britain's recently established Open University utilizes weekly radio programs in conjunction with over-the-air television broadcasting, distributed written material, and part-time class tutors in 250 scattered locations. The University was opened to 25,000 students, primarily adults previously unable to attend college because of social, political, and economic factors. (A similar program was recently established in Maryland).

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3. Evaluation. Radio, due to a number of recent developments, both technological and non-technological, is increasingly being given consideration by educators. The Public Broadcasting Act of 1967 has generated support for and interest in state-wide educational radio networks (Platts, 1968). Two-thirds of the 457 educational radio stations operating as of July, 1970, have been constructed since 1960 (Forsythe, 1970).

3.1 Costs of radio are attractive in comparison with television. Forsythe (1970) estimates radio costs to be one-fifth of those for a comparable television system. Annual radio costs per student generally decrease with an increase in the number of students served. The following annual per student costs are based on a hypothesized metropolitan area model covering 1,500 square miles and serving 600,000 students in 546 elementary schools and 183 secondary schools (General Learning Corporation, 1968):

Production	$1.50
Distribution	.50
Reception	1.50
Total	$3.50

The same model, for comparison, projects total costs for a closed-circuit television system at $11, a cost factor of about three to one in favor of radio.

3.2 Educational implications may be summarized as follows:

1. Radio is a less expensive telecommunications medium than television, but at present, due to generally inadequate funding,

locally originated programming must be supplemented with programming distributed through a number of educational radio networks. This factor, to a certain extent, diminishes the local educator's control over programming.

2. Recent technological developments, most notably FM multiplexing which allows limited feedback, may alter the emphasis of radio programming from cultural enrichment to instruction purposes.
3. Government support for educational radio has increased. This is primarily evidenced in the 1967 Public Broadcasting Act, through which the Corporation for Public Broadcasting recently created National Public Radio. This action has generated new interest in educational radio among educators. Support for creation of state educational radio networks has increased.
4. Radio may be integrated with a number of other media thus making possible flexibility of instructional format. Additionally, radio has transmission flexibilities in that it may use cable or very short-range FM broadcasting, or it may extend its coverage via microwave

and/or satellite.

5. Radio, as an aural medium, places fewer production demands on non-professional broadcasters than does television. Thus, local teachers, students, and administrators may participate in creating radio programs. For the in-class teacher or student, the radio receiver is familiar and easy to use.

6. Certain instructional situations, for example music and language, are readily accommodated to radio's aural mode.

7. As with other telecommunication modes, radio can bring outside authorities and personalities to the classroom. Thus factors of space are overcome. Time flexibility, through the use of audio tape, is also a factor.

8. At present, research results comparing the effectiveness of radio and television as instructional devices are inconclusive (Forsythe, 1970).

9. The adoption of radio to education in the face of recent more "sophisticated" telecommunication systems, may find administrative resistance.

II. TELEPHONY

1. Introduction. A number of educational telecommunications are available that use telephone technology. For purposes of this report, a system is thought of as utilizing telephone technology when the exclusive means of message transmission is via communications links leased from the telephone company and the terminals have both send and receive functions. Thus closed-circuit television systems that lease lines from the telephone company are not considered because they do not provide simultaneous two-way communication. An interactive television computer system, such as MITRE's TICCIT, is not included here because it uses cable television as well as telephone communication links. Some characteristics of telephone networks include (Committee on Telecommunications, 1971):

1. They are engineered to optimize selective (e.g. "switched"), two-way, private, user-to-user communications.
2. As a result of point 1., simultaneous collection of data from many locations to one central location, though possible, is costly.
3. The network is highly interconnected and requires massive capital outlay.

Terminal equipment may include a number of devices used separately or in combination. These include: dial-up or touchtone phone, keyboard, punched card equipment, magnetic tape, low or high speed facsimile, electrocardiogram, electrowriter, cathode ray tube, and even computers. Transmission and relay links include telephone cable, microwave, and satellite. This report concentrates on three educational applications of telephone telecommunications technology: 1. Tele-class, 2. Tele-lecture/Telewriting, and 3. Random Access Audiovisual Retrieval Systems. Additionally, other aspects of telephone technology and their educational implications are briefly mentioned.

1.1 Current developments in telephone telecommunications, both technological and non-technological include:

1. Satellite relay of international calls--the prospect of direct dialing via satellite is in the near future.
2. The U.S. Office of Education's recently established Bureau of Libraries and Educational Technology (BLET) will concern itself with, among other things, video tape systems compatibility. Video tape is an optional component of a (RAS).
3. Transmission of computer stored digital information can take place over telephone communications links.
4. High speed facsimile data can be transmitted.
5. Bell Lab's Video-Phone is being tested in downtown Pittsburgh. At present,

cost factors restrict usage of this device.

6. Temporary conference phone methods between a number of remote locations are available to bring expert resource persons to schools.

7. Administrative functions, such as attendance reporting, can be automated using telephone tie-ins to central computer facilities.

2. Applications.

2.1 Tele-class is used primarily as a temporary communication link between home-bound students and schools. The system consists of a central console at the "school" location, and an automatic dialer which allows the teacher to assemble and interact with up to 20 students. The console indicates which student is speaking; permits the teacher to talk to any or all of the students; at the teacher's option, in turn, each student can hear or be heard by the entire class. A new telephone line is added for each new student up to the 20 maximum. The student part of the system consists of an ordinary home phone fitted with a special jack to which a lightweight headset and voice pickup device are attached. This frees the student's hands for work with his instructional material. The phone may continue normal home use when not being used for Tele-class. Tele-class applications have been made in Los Angeles, New York, Baltimore, and Pontiac, Michigan (Callahan, 1970). Costs for the system vary with location and use. The following example, provided by American Telephone and Telegraph through Southwestern Bell in Austin, gives a cost breakdown of an Oakland County, Wisconsin, Tele-class. Based on average cost per hour of instruction a) Tele-class appears to be more economical than the traditional teacher house visit.

	Tele-class	Teacher Visits
Salaries, car mileage, instructional material	$41,566	$69,645
Equipment and telephone lines	$46,061	N/A
Total Annual Cost	$87,627	$69,645
Total students served	69	140
Annual cost per student	$1,270	$497
Total instructional hours	12,290	3,546
Cost per instructional hour	$7.13 a)	$19.54 a)

The above costs for Tele-Class need some explanation. One point is that all telephone services are leased. The equipment, for example, does not call for long-term capital investment. Each line must be leased for a minimum one-month period. Southwestern Bell representatives estimate, for example, that the monthly line cost for a new student in Texas would be approximately $50, or $40 for the line and $10 initial home installation charge. The line cost varies with distance.

Student and teacher contact may vary according to the subject taught. In some cases the student may contact the teacher at times other than those normally scheduled for instruction. Instructional materials may be mailed or brought directly to the student's home. Tests may be taken directly over the phone or may be mailed in.

2.2 Tele-lecture/Telewriting is used primarily to allow two-way transmision of voice and/or written material between a classroom and a lecturer in a remote location. The Tele-lecture, or two-way voice transmission, consists of a portable telephone monitor containing a speaker which is plugged into a standard telephone jack, additional loudspeakers if needed, and class microphones which may be controlled by the teacher through the monitor. The "remote" lecturer may speak and listen through a normal phone, although use of a two-way, conference speaker-phone releases the lecturer's hands making his task easier. The Telewriter is available in send, receive, or transceiver (send and receive) configurations. Connected by telephone lines or microwave links, the transceiver may, for example, both transmit and record handwritten material. Writing, done by an electric pencil connected to the Telewriter, is on a continuous roll of paper which may be retained for future reference. The written message is recorded by electric stylus on a roll of acetate. In most cases an overhead projector transfers the received copy to a screen. Although no exact data are available, Tele-lecture/Telewriting applications have been made in a number of locations ranging from elementary schools to universities. Carbon County, Wyoming, in 1967, under a Title III grant from the U.S. Office of Education, established a Tele-lecture/Telewriting system to serve schools scattered over its almost 8,000 square miles. The service is used for administration as well as instructional functions. One additional "blackboard-by-wire" system developed by Sylvania uses a hand-held stylus that generates electrical signals based on the stylus movement over a small tablet. These encoded signals are sent by phone line to a receiving position where they are converted to television signals. The writing is then displayed on a regular TV set (Southworth, 1970).

A Tele-lecture/Telewriter system, the Victor Electronic Remote Blackboard (VERB) is manufactured by Victor Comptometer Corporation and used in conjunction with lines leased from the telephone company. Approximate costs for a full Tele-lecture/Telewrite system between two projected locations, one in Corpus Christi, the other in Victoria, Texas, follows:

	Per Month
Two dedicated full-time phone lines, Corpus Christi-Victoria @ $219 ea. (one for voice-one for Telewriter)	$438
Local lines-schools to telephone companies	$ 28
Data-phone for 2 Telewriters	$ 19
Victor Telewriter transceiver @ $46 ea. (sends and receives)	$ 92
Tele-lecture conference phones/monitors @ $15 ea.	$ 30
Supplies (ink, paper, etc.), approximately	$ 10
Total monthly cost estimate	$617

Notes on the above costs:

1. Unless a large volume of traffic was contemplated, dedicated lines would not be desirable. A 15 minute weekday phone call between the two stations is three dollars (this would allow 73 fifteen-minute calls if both channels were used each time). Also, dedicated lines fix the terminal locations whereas the terminal equipment could be switched from place to place so long as low cost jacks are available at each location.

2. Data-phones cost $10 to install at each location.

3. The Victor Telewriter transceiver cost is based on a five year lease agreement at which time the machine may be purchased for about $900 (cost new is $1800) or rented for another three years at one-half the normal rental price of $55 per month. Service and parts costs are included in the rental and lease prices. Also sender-only and receiver-only models are available for purchase, rent, or lease at approximately 65 per cent and 55 per cent of the transceiver costs, respectively.
4. A special overhead projector available from Victor costs $610. It is not available under lease or rental arrangements.
5. A selector box, available from Victor, can distribute one Telewriter sending signal to a number of local receiving Telewriter locations. These are available in various sizes from 5 to 20 location selections. The 15 location selector may be purchased for $615, leased on a five-year plan for $15 per month, or rented at $17 per month.
6. Installation charge is $45 for each conference phone.

2.3 Random Access Audiovisual Retrieval Systems (RAS) is a current, more accurately descriptive term for Dial Access Systems. The term "dial access" is a holdover from the early 60's when dial telephones were used and information access was not random.

RAS is an educational concept that has been partially realized from an increasingly complex technology. The basic purpose of RAS is to provide, by means of various interconnected electronic devices, remote rapid access to audio and video information stored in a central location usually referred to as a media resource library or center. A RAS consists of the following:

1. The remote terminal or study carrel--it may include:
   a. headset or speaker
   b. television receiver
   c. dial, touch-tone, or channel selector access device
2. The switching device (various types--one each required for audio and video)
3. The information storage-response device--it may include:
   a. audio tape recorder
   b. video tape recorder
   c. film or slide chain (a system whereby movie film or slides are televised from a movie or slide projector

for transmission).

Such systems may be fully automatic or manual. In the manual system a person at the media center responds to the student's information request by selecting the appropriate media packet and transmitting it back to the student. The manual system relinquishes some speed for cost reduction through elimination of the automatic switching system. The personnel required for manual systems may be justified in that even automatic systems require skilled help (Wager, 1971). Systems may be totally random, or sequential. Totally random systems permit each student access to each resource whenever he wants it. Sequential access limits student requests to non-accessed materials or he may tap in to a program that is already underway.

Due to the diversity of system designs and manufactured components it is not possible to give representative costs. Also, rapidly changing RAS technologies make cost estimates very tenuous. Most RAS cost in excess of $100,000. Oral Roberts University, Tulsa, Oklahoma, in 1966 made a $500,000 initial investment for its RAS system (EPIE,1971). In Oak Park, Illinois, a totally random access audiovisual system serving about 4,000 high school students cost $1,500,000 (50% of the cost was for research and development). Oak Park uses an Ampex Pyramid system that has unique characteristics:

1. Totally random access is achieved by transferring the requested information from the master storage tapes to the

student terminal, thus releasing the same program for another student. A 15-minute audio program is transferred in 30 seconds.

2. This system is broken down into sub-system modules that permit initial and subsequent design flexibility.
3. Home based students may access the audio programs through a touch-tone phone.

The system has 125 carrels (Southwestern Bell, 1971).

RAS selection is complex and many systems do not always perform as desired. A number of relevant points are (EPIE, 1971):

1. Diverse and rapidly changing technologies make system design difficult.
2. Services by manufacturers and distributors are, in many cases, unsatisfactory because of:
   a. lack of warranty follow-up
   b. lack of industry standards
   c. very cut-throat, high-pressure sales techniques
   d. late deliveries
   e. failure to deliver on system specifications
   f. lack of parts and service

3. System dysfunctions:

   a. poor video quality

   b. poor audio quality

   c. expensive electronic switch maintenance

   d. incompatability with outside phone lines

4. Software:

   a. improperly trained RAS support personnel

   b. relative lack of high quality program materials applicable to specific instructional requirements

3. Evaluation -- Telephone networks are extensively developed. They are engineered for selective, two-way, private information. These two factors posit evolutionary change. Terminal devices and long-distance capabilities are rapidly developing and will offer educators additional options for instructional development.

3.1 Implications for education may be summarized as follows:

1. Telephone networks, because of their switching characteristics and due to other telecommunications systems such as radio and television, play a secondary role in long-distance instruction.

2. Tele-class offers instructional and locational flexibility for home-bound students, and appears to be cost effective. The necessary devices are easy to use, so no special training is required. Such systems, however, require instructional material co-ordination between the student's home and the school. Too, it is necessary for periodic teacher visits to the home for supplemental instruction.
3. Tele-lecture/Telewriting, when used in combination, employ both aural and visual modes. Again the devices are easy to use and, when dedicated lines are not necessary, locational flexibility is provided.
4. Instructional preparation for Tele-lecture-Telewriting does not appear to require any special skills, but again, coordination between the terminal points is required.
5. Tele-lecture/Telewriting permits inter-school sharing of instructional and personal resources.
6. Random Access Audiovisual Systems (RAS) potentially provide for instructional

format and timing flexibilities. They are expensive and have not lived up to expectations because of hardware component incompatibility, poor system performance, questionable manufacturer and distributor practices, and difficulty in system planning.

7. At present, manually operated RAS systems appear to have some practical and cost advantages over automatic systems.

8. High quality, specifically adapted instructional material is not in plentiful supply for RAS.

9. RAS requires strong support from personnel trained in media preparation and library sciences, as well as system equipment technicians.

I. INFORMATION NETWORKS

1. Introduction. For purposes of this report, "information networks" is used to designate electronic systems whose main function is rapid classification, storage, and retrieval of information. A further limitation in the present use of the term excludes audio and visual information retrieval systems (see Random Access Audiovisual Retrieval Systems, III.H. 2.3), and computer assisted instruction (CAI), which is not within the scope of this report. The emphasis is placed on interconnection of information banks where telecommunications technology interfaces with computer technology to form information networks. The computer plays a dual role in the problem of the information explosion, having helped create the problem while providing a way for its possible control. "By 1980 the amount of additional information we will collect will equal in volume all the data produced in the previous two thousand years" (Marks, 1968, p.5). Basically, an information network consists of the following elements:

1. Remote information input (access)/output (display) terminals may include:

    a. electric typewriter

    b. teletypewriter (punched tape and/or keyboard)

    c. cathode ray tube and electric light pen

    d. facsimile

    e. magnetic tape

    f. touchtone telephone

    g. electrocardiogram printer

h. high-speed print-out

i. punched card read-in

(These devices may be used individually and in combination.)

2. Communication lines may include:

   a. microwave relay

   b. coaxial cable

   c. telephone lines

   d. satellite relay

3. Information storage facility consists of various computer central process and storage device configurations.

4. Programs exist for:

   a. network configuration

   b. network operation (including sub-programs for computers)

   c. personnel support functions

1.1 Support for information network research, development, and application has increased during the past five years in government and in education. In 1968, Congress passed an amendment to the Higher Education Act of 1965, Title XIII, "Networks for Knowledge". The goal of this legislation is to encourage the sharing of "educational and related resources" among colleges and universities, public and private (Meany, 1968). Educators, through the Interuniversity Communications Council (EDUCOM), have as their concerns broad applications of computerized

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information retrieval for research, instructional, and administrative purposes.

2. Applications. Though a relatively recent development, applications of information network concepts show diversity in size and function. Sizes range from systems within a university linked by telephone line to inter-university and regional systems linked by microwave relay. Many systems provide access to selected bibliographies, concordances, research data in science, technology, medicine, the humanities, and administrative information. The following examples indicate the range of applications:

1. MEDLARS, Medical Literature Analysis and Retrieval System, established at Bethesda, Maryland in 1964 reviews and indexes approximately 2,400 current biomedical journals and provides demand bibliographies in highly selective subject/author categories. Additionally, MEDLARS issues a periodic index and recurring bibliographies such as Index to Dental Literature. At MEDLARS, highly trained literature analyists index articles. The data are punched on paper tape, read into the computer, and transferred to magnetic tape for storage and retrieval. A computer-driven phototypsetter rapidly converts data stored in computer tapes into photocopy. The photocopy is then used to make the printing plates (EDUCOM, Bulletin of, 1966)

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2. ERIC, (Educational Research Information Center), sponsored by the U.S. Office of Education, comprises 19 regional service centers, each dedicated to a particular area of educational research. At Stanford University "ERIC on-line" is an experimental advanced computer retrieval system that permits direct access to over 12,000 documents in instructional technology. Selected abstracts may be viewed on a cathode-ray screen (Commission on Instructional Technology, 1970). ERIC also makes available original hardcopy and micro-fiche reprints of all documents and publishes monthly document indexes.

3. Information networks are also used for administrative purposes, particularly in larger institutions of higher learning. NEEDS, (New England Education Data Systems based in Waltham, Massachusetts, is an example of administrative use of a computer-directed information network in public schools. The system is currently used for creating and maintaining files, constructing schedules, maintaining attendance reports, analyzing and scoring tests, and recording student grades. In the future it may be applied to instructional uses (Commission on Instructional Technology, 1970).

2.1 Non-technological developments and considerations include:

1. The committee on Instructional Technology in its report, To Improve Learning (1970), recommends creation of a National Institute of Instructional Technology (NIIT) that would "lead in efforts to identify, organize, and prepare for distribution the high-quality instructional materials in all media capable of improving education" (p. 49). The Committee recommends that these purposes be accomplished through a library resource center. In addition the Committee recommends that the NIIT should "strengthen" and "promote" the most promising Regional Educational Laboratories and Research and Development Centers now operating under Title IV of the Elementary and Secondary Education Act of 1965. Presumably these efforts could be accessed through regional and national information networks.
2. Because of high cost factors an information network, particularly its computer element, needs to be operated on a time-sharing basis by a number of users.
3. The concept of sharing also applies to the information available for access.

4. Non-educational though pertinent questions involve societal considerations such as invasion of privacy (credit ratings, medical records, grades), censorship (either by restricting information accessed by networks or the individual's access to the networks), monopoly (in terms of the number of sources influencing content and configuration of information networks), and copyright.
5. Satellites may be used as connectors for long distance worldwide information grids.
6. Washington University in St. Louis is preparing a report for NASA on the Inter-Disciplinary University Program on Satellites, Media and Education (JCET News, 1970, n).
7. Computer technology is changing very rapidly.
8. Data distribution costs, where large numbers of students are at a considerable distance from the central computer, may be greatly reduced by use of multi-channel coaxial cables (Bitzer and Skepardas, 1970).
9. The U.S. Office of Education has recently created a Bureau of Libraries and Educational Technology (BLET). It combines former

Educational Facilities and Educational Media Training Programs. BLET is interested in developing regional educational R&D centers and developing new patterns of library use. BLET and NASA have been discussing possible educational applications of satellites (JCET News, 1971, a).

3. Evaluation. The information explosion and the resultant problems of information classification, storage, and retrieval have created a need for application of information network concepts. Recent creation of such networks, though relatively "primitive", bodes for their increased development during the remainder of this decade. Though not discussed here, the computer's potential for efficient individualized student instruction is great.

3.1 Educational implications may be summarized as follows:

1. As with other applications of telecommunications technology to education, computers and information networks make necessary increased instructional planning and inter-institutional cooperation on state, regional, and national bases.
2. The emphasis of the teacher's role changes from that of prime source of information content to that of source for

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information access strategies. Also, one of the promises of computer assisted instruction (CAI) is releasing the teacher from dull, instructional drill tasks and administrative detail to concentrate on giving personal, individualized attention to each student.

3. Information networks may serve three basic functions: a. research, b. instructional, and c. administrative.

4. High costs and rapidly changing technology support the sharing activities implicit in point 1.

5. Technological improvements in rapid access, audiovisual retrieval systems will change the basic "printed" information characteristic of present information networks.

6. Information networks provide for time flexibility both in terms of their rapid access and their around-the-clock availability.

7. Highly trained and highly paid personnel are required for design, implementation, and operation of information networks.

8. The development of home information terminals hooked up to information networks may require changes in the present concept of

classroom location and configuration.

9. Information network message replication costs become more attractive with increases in network size.

CHAPTER IV

PROJECTION OF TRENDS

A. INTRODUCTION

Again the overall purpose of this report is to identify and discuss current trends in telecommunications technology--their applications and implications for education. As stated, this was accomplished by surveying, collating, and evaluating information from diverse sources in industry, government, and education. A pervasive trend identified was the time lag between technological development (hardware) and instructional development (software) and the eventual practical application of these. That is, hardware breakthroughs have tended to obscure the instructional goals of education. Also, telecommunications, by definition, presents unique abilities for overcoming strictures of time and space.

As described in Chapter II, current trends in hardware and software are:

Hardware

1. Microminiaturization of equipment and information.
2. Increased message transmission capacity.
3. Two-way (inter-active) information flow.
4. More complex and complete information grids.
5. Faster and longer long-distance communications.
6. Multi-media use of technologies.

Software

1. Self-paced instruction.
2. Inter-disciplinary instruction.
3. Greater student involvement as an active learner and element in learning environment design.
4. Increased stress on relevancy in the educational process.
5. Changing teacher roles (concepts) such as team teaching.
6. Scheduling flexibilities for instruction.

These general findings cut across a number of technological developments. The telecommunications systems and their educational impacts that were discussed were:

1. Educational television (ETV)
2. Closed-circuit instructional television (CCITV)
3. Instructional Television Fixed Service (ITFS)
4. Video tape recording - Video cassettes (VTR)
5. Satellites
6. Cable television (CATV)
7. Radio
8. Telephony
9. Information networks

The projection of trends in hardware and software, and their educational implications, are next discussed for each of the above systems, except that CCITV and ITFS have been combined due to their commonality of application. To provide for monitoring of future developments in trends, sources of information are suggested in brackets. These sources appear in a special list at the end of this chapter. Occasional reference is made specifically to implications for actions on the level of a state agency since this report was prepared for such an organization.

B. EDUCATIONAL TELEVISION

Educational television, defined for this report as nonprofit, publicly sponsored, open-circuit broadcasts of educational, cultural, and public affairs programming, is primarily a software concept. However, it is continuously affected by hardware developments.

Hardware

1. Satellite transmission of programs will increase in the mid-to-late 1970s [D, R] pending the outcome of NASA's efforts to develop the broadcast satellite, the development of low cost earth receiving stations, and the creation of a domestic satellite system [I].
2. Video tape recording use will increase and become pervasive as technology in that area develops [A, I, BB]. Video cassette use will continue to be slow for the next two or three years, but should increase during the second half of this decade [C].

3. Cable television will increasingly become a means for local distribution of ETV programming [T, U]. Technology will provide for spontaneous audience feedback and monitoring in the mid-to-late 1970s, pending national ordering of priorities for CATV use [Y, Z].

4. A fully dedicated (i.e., private) nationwide transmission system will be completed by 1974 (JCET News, 1971, f.), [Q].

Software

1. Permanent federal funding of the Corporation for Public Broadcasting (CPB) will be effected in the next few years [Q, U, P].

2. Increased origination of local programming will be encouraged and supported by CPB. This will require state-level monitoring and coordination of local ETV programming [see U].

3. Evaluation of educational programs will take place during the creation of the programming and will feed forward for continued program revision and eventual summary evaluation of program effectiveness. Evaluation will become more formative in that early pretesting of program segments will provide

"feedforward" into the production process. Programs will have increasingly specialized audiences with programming goals stated as behavioral objectives. State level monitoring should be required so that dissemination of these efforts to local educators is achieved.

4. Increased audience participation in public affairs programs will be seen. The state could occasionally bring communities together for statewide town-hall meetings.

5. Program exchange between ETV and instructional television (ITV) systems will increasingly take place as the distinction between the two systems continues to blur. Both systems will want to cooperate on program creation and evaluation. The state could serve as a coordinating body for these efforts [S].

6. Programs will be increasingly syndicated for distribution. The state could provide regulatory guidelines for syndication. It will want to monitor the activities of other states and national regulatory agencies [Q, S, X].

7. Providing public services such as "soap-box" forums will also be done on ETV. This will take place to a greater extent where a local cable television system exists.

8. William Harley, President, the National Association of Educational Broadcasters (NAEB), has urged that public broadcast stations become public telecommunications centers offering a myriad of services to the community (Harley, 1971).

9. Distribution systems for public telecommunications centers might consist of Instructional Television Fixed Service (ITFS) transmission of signals to cable television headend distribution points (Harley, 1971). ITFS systems, because they require a special receiving antenna and signal conversion device, will occasionally use cable systems for program distribution to audiences not equipped to receive ITFS signals [S].

. CLOSED-CIRCUIT INSTRUCTIONAL TELEVISION

For purposes of trend projections, closed-circuit nstructional television (CCITV) and Instructional Television ixed Service (ITFS) are combined to reflect their common haracteristics as modes for the controlled transmission and istribution of instructional programming.

Hardware

1. Broadcast satellites equipped for ITFS transmission and available for interconnection

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of CCITV systems will become increasingly available to educators in the second half of the decade.

2. CCITV systems will increasingly utilize radio frequency (RF) transmission as this method permits multi-channel flexibility and is capable of covering greater areas.

3. Television reception equipment will change in two directions. One will be large, slim viewing screens available for hanging on a wall or for use as built-in media fixtures [AA]. Image clarity will be greatly enhanced. Another direction will be the availability of low-cost, pocket size television receivers. Similar to recent developments in portable radios and audio cassettes, these mini-screen receivers will be able to pick up local television broadcasts as well as play-back video cassettes. These sets will be commonplace in 10 to 20 years. Increased reliability will be realized.

4. Three dimensional, life-size images on television screens using holographic techniques will be slow to develop unless a major breakthrough in technology not now evident occurs (Lessing, 1971). In any case this development

will not be influential before the end of the next decade.

5. Equipment able to effectively utilize extremely high frequency spectrums will enable more channels to be accommodated on an ITFS-like system [H, J, L].

<u>Software</u>

1. CCITV will increasingly be used in concert with other coordinated or packaged instructional-learning media such as radio and printed materials.

2. Multi-media use as indicated in point 1. will require increased coordination between teachers, administrators, and curricula and media specialists. The need for these applications will be recognized at the local school or school district level. Fulfillment of this need through creation of appropriate instructional packages will require coordination between, and the participation of, state, regional, and national instructional research and development laboratories, as well as production and distribution centers [E]. These interactions should be orchestrated at the state level. The state should be sensitive and responsive to local needs and yet have the perspective and influence

to bring regional and national resources to bear. This will require a state agency to monitor and lobby for federal activities and support of educational and instructional development [X].

3. Exigencies of funding and cooperation will require an eclectic approach to formation, operation, and evolution of administrative bodies at the local, state, and national levels. Again, the state is ideally situated as a middle-level organization to bring about these changes. More systematic analysis of inputs, processes, outputs, and goals will be required for this administrative effort. Comprehensive development of software will make possible the effective use of telecommunications hardware for administrative, as well as instructional purposes.

4. By definition, CCITV systems are primarily concerned with instructional programming. The increased demands made on educational institutions by adults for continuing education, especially in the large urban areas, will require program format, distribution, and scheduling flexibilities such that increased interaction between CCITV and ETV

systems will be necessary. Job skill retraining, for example, will be in high demand as the roles of the technologically displaced increase [F, K]. Also, emphasis will be placed on initial and developmental career training by sponsoring federal agencies such as the Departments of Labor and Commerce and the U.S. Office of Education [CC]. Industry, too, will increasingly become involved in these efforts as a source of creative resources and funding. Increased efforts will be made to wipe out illiteracy and eliminate the school drop-out problem. The state will need to monitor and coordinate these efforts.

5. The FCC is encouraging local inter-institutional organization of ITFS systems. It is making more than the normal four channels available to applicants who demonstrate a need for increased channel capacity based on cooperative efforts such as time-sharing of proposed systems.

6. Related to the above point, the FCC is keeping a hands-off attitude by letting local authorities decide the configuration and uses of proposed systems. Should educators not make concerted efforts to take advantage of these opportunities, then the FCC will undoubtedly

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take a stronger, less desirable stand on ITFS system use. The state should stimulate local efforts and be the liaison between such efforts and FCC responses to them. Additionally the state should be an information coordinator between local educators in different communities.

7. Increasing shortages of available ITFS frequencies and resulting frequency interference in some areas may require imposition of more stringent equipment engineering standards [H, J, L]. Also, should allocation of extremely high frequencies become available, the equipment able to accommodate these frequencies will be expensive. This point makes the traditional closed-circuit systems potentially cost effective.

8. Technological developments providing for system configuration flexibilities and program interchange point toward the educational goal of truly individualized instruction and interaction between student and teacher. The state should identify, monitor, and bring together outstanding teachers and programs for application to different locations where an educational-learning need is not being met by local efforts.

9. Application of hardware systems will require increased reliance on design engineers.

10. Production by local centers is likely to continue, and may very well flourish (NAEB, 1970). This will require increased training for local teachers and administrators. Again, the state could sponsor workshops and conferences to facilitate these local efforts.

11. Classroom environments are becoming more flexible and mobile. Traditional methods of fixing the boundaries for school districts might change. The state, in close cooperation with local authorities, could serve to help delineate and administer these new and changing configurations. The spatial flexibilities inherent in telecommunications will become especially attractive as populations change. The state will want to accommodate this variable in its planning by a more direct dual use of census and educational data banks.

12. Learning goals, specifically identified, and instructional strategies designed to attain these goals, will precede the choice of a particular medium or media combination. The development of large screens and, eventually, three-dimension image projection (Lessing, 1971) will make television uniquely effective

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for certain courses, such as biology and other sciences where critical observation is required. Also many liberal arts courses such as history, geography, and drama will benefit from the increased perceptional dimensions available through these projected technological developments.

13. Local control of instructional program format and content will remain an important factor.

14. Satellite broadcast transmission and relay will be used occasionally to link various locations within the state for presentation of special live news events or instructional programs. The state could participate in the funding and utilization of satellites with other state, national, and international organizations. It will be important to monitor these sources [D]. Eventually live instructional interactions could regularly take place between American students and students from other parts of the world.

D. VIDEO TAPE RECORDING—VIDEO CASSETTES

Video tape recording (VTR) and video cassettes will become less expensive, more reliable, and more portable. Their almost unlimited applications will make them a pervasive element in all television systems.

Hardware

1. Battery-operated color video cameras and drop-in video cassettes will be available in the second half of this decade. They will be used much as the present 8mm home movie camera is used today.
2. Video cameras in addition to recording and instantly previewing program material will contain small, low-power transmitters that will eliminate the need for a distinct, wire-connected recorder-playback device for television monitor viewing. This will be seen in the next decade.
3. VTR hardware compatibility will emerge in the middle to latter part of this decade [B, I, BB].
4. The image quality for small format VTR's will improve, making them acceptable to broadcast standards [J].
5. Various video storage and play-back devices connected to a television receiver information terminal will automatically store and make available programs originating from a distant location.

Software

1. VTR will continue to be used for short-term storage of programs. Tapes will be reused

many times as instructional situations call for newly created material.

2. Characteristics of economy, portability, ease of use, instant replay, and stop-frame, and editing capability, will make VTR especially useful in instructional situations such as critiques of speech, drama, athletic performances, teacher interaction in learning situations, guidance counseling, administration, public relations, and anywhere immediate visual and aural feedback will reinforce and modify human behavior. VTR "portable television studios" will be increasingly available to everyone involved in the educational process.

3. Increased component compatibility and broadcast performance capability will enable more interchange of instructional materials between various educational entities [E, G, I, K, L]. As pointed out in CCITV projections, the state can play the role of coordinator for a number of educational entities. The state may, for example, classify and catalog tapes available for distribution, and also make known to other educators the particular needs of a local school or teacher.

4. Video cassette use will increase during the latter part of the decade as production cost breakthroughs, and problems of system compatibility and program availability (through resolution of copyright questions) are resolved [B, C, BB]. The state will have to make special efforts to stay informed of emerging developments [E, J, L, S, U].
5. VTR use will increasingly replace film systems in the future. The state will need to coordinate local planning and purchase activities of audiovisual aids to reflect this changing pattern of use [E, I].
6. The effective use of VTR will require training of teachers and students. Area workshops should be promoted.

E. SATELLITE

Satellites will offer increased capability for "instantaneous" two-way global communication in a number of available modes (e.g., voice, video, facsimile, etc.). Prospects for educational interaction among nations is a distinct possibility.

Hardware

1. Development of high power broadcast satellites and low cost terrestrial receiving stations will take place in the next six to twelve years (Busignies, 1971).

2. ITFS transmitters will be included in satellites in the next few years [D, Q, R].
3. Demand assignment multiple access (DAMA) will permit two or more ground locations to have two-way communication using the same satellite. Today channels must be pre-assigned (i.e., dedicated) between two points, or be multi-destination carriers (Pritchard, 1971).
4. Satellite transmission capacity, in terms of the number of satellites in operation, and their individual channel capacity, will increase. Per satellite channel capacity may reach 100,000 circuits by 1985 [D]. This, along with a possible increase in satellite frequency allocation, will permit band-width flexibilities. Thus many different types of data modes will be available for use. Also, the emphasis will be on launching satellites with increased circuit capacity in order to avoid complex traffic routing problems and the need for new terrestrial antenna beams (Pritchard, 1971).

Software

1. Satellites, because of their unique abilities to overcome administrative and political

boundaries and time zone differences, require coordination of policy development and application among many levels of government [X]. National and international regulatory bodies will be initiators and administrators of overall satellite policy, but state and local interests will be the input sources of data upon which such policies are created and effected [J].

2. The state should, again, monitor and be the liaison body between local and national interests.
3. Through the remainder of this decade, with the realization of a domestic satellite system, local educators will begin to utilize the satellite transmission mode. This use will be limited to importation and sharing of special news events and instructional programs. The state could request and administer satellite use as a member of a national organization created for such purposes [D, G, R, S, Y].
4. Satellites will be used for statewide, national, or global "conference calls" and eventually for educational interaction among students from many nations. This

development will provide substantial opportunity for language instruction and practice between students of different countries.

F. CABLE TELEVISION

The term "broadband communications network" (BCN) will replace the term "Community Antenna Television" (CATV). This modification of terms reflects the changing nature of cable transmission capacity and the projected evolution in its use. Broad bandwidth will permit two-way communication (feedback) and will accommodate various types of data transmission.

Hardware

1. Developments in cable switching devices will permit greater variety and volume in feedback responses. These switching devices will require an individual (response channel) cable for each remote terminal. Each cable will tie in to a central switching device. This will eliminate problems of sequencing responses due to response channel overload (Committee on Telecommunications, 1971).
2. Cable circuit transmission capacity will increase to 80 or more channels by the end of this decade [T].
3. A number of terminal configurations will be available including black and white or color

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television receivers, audio and video information storage and play-back devices, still frame television hold and refresh, teletype and typewriter readout and input, touchtone phone, facsimile [FF], and plasma display screens. Provisions for discrete addressing of messages to terminals will be utilized.

4. Coaxial cable will be the basic BCN carrier mode, although microwave, millimeter wave, and paired wires will also be used. Paired wires can carry up to one video channel, "but microwave and millimeter wave offer bandwidths potentially as great as cable" (Industrial Electronics Division, 1969, p.30).

5. There will be moderate use of BCN for intra-city discrete address delivery of mail by high-speed facsimile at the end of this decade, and long distance service by satellite in the late 1980s [D, T].

6. There will be increased use of BCN for transmission of digital information between computer information banks.

7. Electronic home library service will transmit requested materials by BCN [CC]. The user may either receive the materials one page at

a time at the rate of his reading speed, or he may receive the copy of the entire manuscript for his use. Sophisticated systems able to transmit color and graphics at an economical rate will not be available before the end of this decade.

8. Multiple address mailings by facsimile may be multiplexed with broadcast television signals [J, FF]. A field test of the multiplexing technique has already taken place (Industrial Electronics Division, 1969).

<u>Software</u>

1. BCN systems, due to their wide band transmission abilities, will increasingly be used for a variety of one-way and two-way information flows in instructional situations. Problems of media use, availability, and coordination will be best handled at the state level.

2. Recent FCC decisions require cable systems in the top 100 market areas to set aside free channels for ETV use (as well as channels for other public services such as shopping, polling, voting, etc.). There will be a five year period to test the feasibility of this requirement. Local educators need to become

immediately aware of the availability of free cable channel capacity in their areas. The state will want to spur interest among diverse community institutions and individuals so that this opportunity is developed to its full potential. The state should monitor regulatory developments and lobby for favorable FCC rulings [J, Q]. It can serve as the liaison agent between the federal government and local educators and interested citizens [X].

3. The abilities of BCN to deliver specified programming to well-defined audiences, and its capacity for monitoring audience response to such programs, are important for educators. Combinations of school controlled ITFS transmission facilities and cable distribution systems will enable educators to design any number of learner-instruction dimensions. The problems of desegregation will be served by the ability to deliver equal educational opportunities to all students.

4. State resources and perspectives will be required to effect creation of comprehensive multi-media library information centers. Access to this information will greatly

improve as methods of information classification, access, and distribution by information networks develops. The state can be a clearing house for such efforts.

G. RADIO

Though often overlooked in favor of more sophisticated alternatives, radio will increasingly provide a relatively easy and inexpensive means of bringing together the elements of many instructional and learning situations.

Hardware

1. Multiplexing, which permits a number of different signals to be simultaneously transmitted, will become increasingly sophisticated such that alternatives, including two-way communication, will be available to the instructional designer.
2. "Educasting," a very short-range, closed-circuit, multi-channel audio transmission system, will be increasingly used. Such equipment will become less expensive, easier to use, and more reliable as technological breakthroughs result [W]. Lack of regulatory restrictions make such systems attractive for instructional experimentation [J].
3. The range of low-power radio transmission systems will increase.

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4. Satellite relay of radio, especially to geographically remote areas, will increase [Q, R].

5. Audio tape recorders will continue to become less expensive, more reliable, more versatile, and easier to use [B, BB] in conjunction with radio broadcasting.

6. Provision for controlled transmission of tele-radio signals through use of other tele-communication technologies such as cable distribution and sophisticated switching devices, will emerge.

7. Portable radio receiver audio tape or record-play-back systems will be commonplace due to their versatility and economy [B, I, X, AA, BB].

Software

1. Radio, because of its unique operating characteristics and relative economy, should not be overlooked in favor of more sophisticated and glamorous devices [S].

2. Radio will be naturally combined with other media to realize instructional objectives. There will be an increase in the design and application of this multimedia approach. As with other media developments and applications,

the effective use of radio will benefit from state participation in planning and operating educational and instructional radio networks.

3. Radio's relative operational simplicity will increasingly draw the participation of teachers, students, and administrators into the creation and dissemination of instructional programming.

4. The aural mode lends itself to effective application in such instructional situations as language and music.

5. Regional and national research laboratories and production centers, as is true with television, will be created and will play an increasingly important role in radio [G, I, U, CC]. Suggestions concerning state involvement with these institutions in the areas of educational and closed circuit instructional television are relevant here.

H. TELEPHONY

Telephony transmission and terminal technology will continue to evolve. Applications to education will increase in number and variety. The ideas for these applications will be generated as much by the educational community as by the telephone companies.

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Hardware

1. Picture phone installation, unless a technological breakthrough permits cost reductions, will be slow for the next two decades [A, EE]. There might be a two to five percent market penetration by the year 2000 (Busignies, 1971).
2. There will be portable mobile data terminals connected by radio telephone to central locations.
3. There will be integrated voice-data private exchanges [O] which will access information through terminals and displays and will furnish hard copy (Busignies, 1971).
4. There will be long-distance dialing to any global location via satellite or international submarine cables [O, R].
5. In the distant future, there will be simultaneous translation of languages during conversation (as is done in the United Nations). Automatic language translation is not foreseeable (Busignies, 1971).
6. Telephone transmission capacity will benefit from developments in cable technology.
7. There will be switched "store and forward" networks in which a message will be transmitted

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to a center for temporary storage-hold before being released to a particular address in an available channel (Busignies, 1971).

Software

1. Terminal devices such as the touchtone telephone will be used as response and access equipment in conjunction with various formats of programmed instruction [M, EE].
2. Conference calls will be used either alone or in connection with video and facsimile modes to erect temporary interactive live information networks. Educational broadcasters will increasingly use teletype, facsimile, and wide area telephone service (WATS) lines in conjunction with their normal operations (NAEB, 1970).
3. The transceiver model telewriter, because of its interactive ability, will be preferred over the receive-only or send-only models [DD]. Also, except where high traffic use is projected, telephone connection of remote locations will be by demand rather than dedicated (i.e., private) telephone lines.
4. Tele-class will remain feasible for interaction of designated at-home small student groups. During the next decade developments

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in low-power, short distance radio transmission/reception will challenge the tele-class concept [J, W].

5. Recent FCC allocation of additional frequencies to mobile radio telephone supports the contention made in the above point.

6. Random access audiovisual information systems (RAS) utilizing telephone line transmission and switching will develop. Important questions of systems specification, cost, reliability and compatibility will need to be resolved [I] before full realization of RAS potential takes place. Also, problems of program availability and quality will need to be resolved.

7. As with other telecommunications systems, effective use of telephone will require state participation in many ways. The state should monitor industry and government sources for emerging trends [H, M, O, EE].

I. INFORMATION NETWORKS

Technology is changing very rapidly in this area, particularly for computers. Here the gap between hardware breakthroughs, effective software development, and eventual realistic application is most dramatically felt. The potential for education is great, but so is the cost.

Hardware

1. The speed, reliability, and flexibility of computers will increase tremendously [N].
2. Computer installation growth will slow down toward the end of the decade. Even so there will be $100 billion of investment by 1980.
3. There will be automatic control of timing for information retrieval, storage, and display at remote terminals.
4. The possibility for an integrated data system (i.e., one that would accept many different message transmission modes) will be realized in this decade.
5. Desk-top, plug-in, portable computers with adequate storage and computational specifications will be available at the beginning of the next decade. Costs should decrease due to technological breakthroughs and resulting efficiencies of mass production and wide-spread marketing.
6. Information storage space requirements will be drastically reduced through such technological breakthroughs as holographic embossing of thousands of micro-dots on "film-cubes" (thick film-like material in cube shape). For example the entire Encyclopedia Britannica could be

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stored in a one square-inch film cube (Lessing, 1971).

Software

1. The computer will be a subject of study. Different aspects of computer operation, use, and programming will be taught as will information theory.
2. The interactive use of the computer in education, science, and business will lead to home-computer interaction on a time-sharing basis at first. Introduction of individual home computers will eventually eliminate time-sharing.
3. Increased federal funding and changing local attitudes will increase the demand for computer assisted instruction (CAI) and supporting equipment [V, CC].
4. The central purpose of media libraries will be to collect, index, and distribute "single-concept" materials selected by the teacher for integration into a particular course (NAEB, 1970).
5. By 1975, 80 percent of the computers will be linked to communication networks (Busignies, 1971).
6. Costs will hinder large scale development of random access central libraries for the next

10 or 15 years although small scale information centers will proliferate [P].

7. The state can serve as a clearinghouse for information identification, collection, classification, cataloging and dissemination. It will serve as liaison between in-state, regional, and national groups connected with information network development. These groups will include government, industry, and educational interests.

8. Telecommunication information networks linking computer information centers will provide schedule flexibilities for instructional and administrative purposes. Instruction, for example, could take place any time between the hours of six a.m. and ten p.m. with administrative record keeping accommodated during the late night and early morning hours.

9. Information networks, by the end of the next decade, will themselves be interconnected via satellites to world-wide information grids [D, P].

10. Individualized instruction both in terms of subject matter and learning pace will be fully realized through network-connected computers.

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J. A CONCLUDING VIEW

As can be seen throughout this report, progress in the educational applications of telecommunications technology is a constant interplay between hardware innovations and software applications. It seems reasonable to argue that our views and applications of this progress have been susceptible to several distortions. For one thing, technological breakthroughs in telecommunications are often touted in terms of practical applications. Yet these actual applications, which must accommodate factors of reliability, economy, and practical use by humans, are often a greater challenge than the technological breakthrough itself.

A second problem is that the hardware-to-software order of progress has often allowed the technological innovator rather than the educational innovator to plot the course of developments. Telecommunications technology now offers a sufficient variety of systems such that the educational planner should take the lead in development of applications--thus establishing a software-to-hardware order. He will do this by being able to specify learner audience, learning goals, and the instructional media and methods needed to effectively orchestrate all elements of the learning environment. State and federal agencies will have to take the lead in effecting this reorientation.

K. SOURCES FOR MONITORING TRENDS

A. American Telephone & Telegraph Co.
195 Broadway
New York, N. Y. 10007

B. Ampex Corporation
Educational and Industrial Products Division
2201 Estes Avenue
Elk Grove Village, Illinois 60007

C. Columbia Broadcasting System, Inc.
Electronic Video Recording Division
51 West 52nd Street
New York, N. Y. 10019

D. Communications Satellite Corporation
950 L'Enfant Plaza S.W.
Washington, D. C. 20024

E. Department of Audiovisual Instruction
(New name: Association for Educational Communications and Technology)
1201 Sixteenth Street, N.W.
Washington, D. C. 20036

F. Department of Commerce
Office of Telecommunications
14 Street between Constitution and E
Washington, D. C. 20230

G. Department of Health, Education, and Welfare
Director of Telecommunications
North Building, Room 5411
330 Independence Avenue
Washington, D. C. 20201

H. Department of Transportation
Systems Development and Technology
400 Seventh Street, S.W.
Washington, D. C. 20590

I. Educational Products Information Exchange Institute
386 Park Avenue South
New York, N. Y. 10016

J. Federal Communication Commission
1919 M Street, N.W.
Washington, D. C. 20554

K. Ford Foundation
Division of Education & Research
320 East 43rd Street
New York, N. Y. 10017

L. General Services Administration
Office of Telecommunications Engineering & Requirements
GSA Bldg., 18th and F Streets, N.W.
Washington, D. C. 20405

M. General Telephone and Electronics Corporation
730 Third Avenue
New York, N. Y. 10017

N. IBM Corporation
CPO Box 120
Kingston, N. Y. 12401

O. International Telephone and Telegraph Corp.
320 Park Avenue
New York, N. Y. 10022

P. Interuniversity Communications Council
100 Charles River Plaza
Boston, Massachusetts 02114

Q. Joint Council on Educational Telecommunications
1126 Sixteenth Street, N.W.
Washington, D. C. 20036

R. National Aeronautics and Space Administration
400 Maryland Avenue, S.W.
Washington, D. C. 20546

S. National Association of Educational Broadcasters
1346 Connecticut Avenue, N.W.
Washington, D. C. 20036

T. National Cable Television Association
1634 Eye Street, N.W.
Washington, D. C. 20006

U. National Educational Television
Public Information Division
10 Columbus Circle
New York, N. Y. 10019

V. National Science Foundation
Room 536
1800 G. Street, N.W.
Washington, D. C. 20006

ERIC

W. Norelco
Training and Education Systems
North American Philips Corporation
100 East 42nd Street
New York, N. Y. 10017

X. Office of Federal-State Relations
National Governors' Conference
1735 DeSales Street, N.W.
Washington, D. C. 20036

Y. Office of Telecommunications Policy
Executive Office of the President
Washington, D. C. 20504

Z. Sloan Commission on Cable Communications
105 Madison Avenue
New York, N. Y. 10016

AA. RCA Corporation
30 Rockefeller Plaza
New York, N. Y. 10020

BB. Sony Corporation of America
47-47 Van Dam Street
Long Island City, New York 11101

CC. U.S. Office of Education
Bureau of Libraries and Educational Technology
7th and D Streets, S.W.
Washington, D. C. 20201

DD. Victor Comptometer
Electro-Writer Sales and Services
106 Broadway
San Antonio, Texas 78205

EE. Western Electric Company
195 Broadway
New York, N. Y. 10007

FF. Xerox
Business Products Group
Rochester, New York 14603

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