Teleducation: Networks For Knowledge

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EDUCATIONAL TELECOMMUNICATIONS—teleducation—has been in commercial and industrial use for some time, yet is relatively new and unfamiliar to many in our school systems. Our traditionally operated school systems are so outdated and far behind in the art of information dissemination that we are lagging behind other world powers and societies. Not enough teachers, schools and facilities, nor money will be available to do a top level job of information dissemination and to meet our future educational needs if we continue to operate as we have in the past. The use of new technological aids to education and information dissemination could reduce the daily load on teachers and improve the utilization of personal competencies just as technology did during the Industrial Revolution.

A concept study of total educational telecommunications systems shows that our society is made up of interdependent systems and subsystems. As technology becomes more advanced it becomes more and more critical that all levels of our society be able to communicate and interact. Our past educational system has not prepared us well enough to do this; a radically different approach to educational communications is needed to coordinate systems and make them relevant to society in general. Considerable effort and understanding are required in the direction of system coordination.

Many disadvantaged areas of education, economy, production, knowledge and skills occur in society which seriously retard what might otherwise be a faster moving systems economy. One way to eradicate these problem areas might be to provide more and better educational communications subsystems to interconnect the poverty areas with the affluent areas.

People still believe in the importance of education but are asking for significant improvement in quality and quantity. The Office of

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Research and Development of the National Association of Educational Broadcasters suggested to the Commission on Instructional Technology in its report to the President and Congress of March 1970 that we will probably see the electronics medium supply basic components of a new instructional system for school, university and other training facilities. It will be in effect a development which will make possible the higher levels of instructional productivity and efficiency needed for effective implementation of truly universal educational opportunities.

One of the most relevant national level studies and reports on *Automation and Technology in Education* was a book-sized report of that title by a joint congressional subcommittee on economic progress of the Eighty-ninth Congress, second session.[1] Their summary release of August 18, 1966, points out needs, cautions, potentials, and urgency for educational communications systems analysis, application development and the evaluation and extension of all such services. A good case is made that teleducation, or an educational technology automation revolution, is in the best national interests.

Outside the field of education a culture of electronic communications knowledge, information dissemination and changing skills is making its presence known worldwide. A large problem may well be to match the educational system and its output to our electronic communications culture—one that has produced a revolution of rising social and economic expectations.

A comprehensive educational communications systems analysis must include a wide range of system and subsystem study for resolving teleducation problems and identifying objectives and procedures. Such teleducation considerations should also include deliberations on known media such as computer-managed operations and programming, instructional television fixed service, computer-assisted learning laboratories, remote random access interconnections, person-to-person response systems and teleconferencing. Additional focus should be on library materials interchange, information retrieval, and selective dissemination, to name a few. Cable television (CATV), wired city/nation concept potentials, and new kinds and magnitudes of software studies and developments should also be explored.

Several recent national level in-depth government and nongovernment reports stress the importance of educational/instructional technology applications and the need for massive improvement programs in most types of in- and out-of-school education.

Government and nongovernment studies show that the present state of the art can provide the know-how to implement a federal and/or intercontinental level of "Networks for Knowledge." A federal level implementing bill concerning such a network was passed as Public Law PL90-575, Ninetieth Congress, October 16, 1968, S3769, Higher Education Amendments of 1968, Title VIII, "Sharing Educational and Related Resources." Appropriations were authorized for over $19 million to the end of fiscal 1971. At this writing, however, Congress had not yet funded it.

Long-term educational needs will require a much greater proportion of support than is now in evidence in the software effort; hardware can only serve as the vehicle.

In the field of education the teaching content still must come from teachers, although it seems obvious that eventually video recorders, film chains, and other auxiliary devices will be required and used regularly as one of many subsystems to meet special schedules and needs.

Tremendous industry, public and Federal Communications Commission (FCC) attention has been focused on CATV. The system has grown to over 2,300 systems in the U.S. which serve 4.5 million subscribers; the largest system serves 35,000 subscribers. Sixteen systems serve over 14,000 subscribers each, the total of 14,000 being the number of subscribers in the U.S. twenty years ago. Last October the FCC ordered CATV operators serving more than 3,500 subscribers to originate some local programming, in addition to merely connecting or repeating conventional off-air programs, which should result in more channels of better quality being available on cable. CATV "wired city" and "wired country" concept areas will be interconnectible to better cover wider areas. Satellite will undoubtedly become part of the interconnecting picture for some inter-area and intercontinental applications.

Evidence indicates that if most of the statewide public service agencies needing wide area communications could be tied into a properly coordinated foundation system, then all could get better and more extensive service for appreciably less cost per user message. Costs could be apportioned among the state police, highway commissions, conservation commissions, farmers' weather warning services, public health, public assistance, etc. Applications for licenses for cross-country microwave systems have deluged the FCC in Washington, since it appears that the FCC might allow these systems to parallel some common carriers. This movement may significantly aid all forms of information, knowledge, and educational communications management.

Interstate wide-band communications networks would permit the transmission of information coast-to-coast at astonishing speed—the contents of a 500-page book have been transmitted in five minutes. Instructional materials centers, school and public libraries, etc., in a state could have continuous access to a single state master library for information searches and retrievals, and teaching materials. Conventional information access and retrieval systems are in operation, as well as a computerized national level medical information file, with slow-speed conventional narrow-band telephone channels. The wider the band width, the faster these systems can work, and the more channels can be multiplexed, i.e., one television channel can support over 2,000 telephone channels.

Some states are already planning to use some type of multiplex channels over conventional broadcasting channels. Four printing or control channels may be superimposed/multiplexed on a conventional television channel. This would mean that one educational television (ETV) channel into a school might also carry four channels of conventional-speed printing which could contain library/reference information simultaneously with the picture. One FM broadcast radio channel can use subsidiary communications authorization (SCA) multiplex to carry (in lieu of two channel stereo) two audio and two narrow-band printing or control channels into the school on one FM broadcast base channel. (SCA has been in use several years for many commercial applications.) This means that two conventional broadcast channels into the school could be converted into nine mixed information-knowledge lesson channels, if less costly methods do not become available. Another method would be to duplex one audio and one fifty words-per-minute radio printer simultaneously on one normal audio channel. Where real time lip-synchronous television may not be necessary, it is feasible to send "slo-scan TV" on one audio channel (somewhat like "blackboard by wire") with accompanying audio on another channel, and thus electrically transmit audiovisual information by wire on conventional audio magnetic tape. Similarly, it is possible to transmit an audiovisual course sequence by radio or telephone, record it on a conventional audio tape recorder and store, delay and play it back later, in or out of school. Many such approaches are both practical and economical, if the complete system is correctly planned and implemented with software support.

Another advance concerns speech time compression (STC) of audio teaching materials. If the rate of the conventional talker (100 to 150 words per minute) could be matched to the thinking and auditory /hearing rate of the listener (500 to 600 words per minute), in order to prevent listener mental thought idleness and wandering three-fourths of the time, then learning perception and mental retentivity could be improved, as well as saving millions of man-hours of learning time. This has been easily and economically done in commercial recording/taping applications for some time. Also, much of what appears on TV could be done as well on audio only or radio. One ETV channel could support 2,000 audio teaching channels, each of which could possibly save substantial amounts of learning time. It is suggested that the introduction of some of these methods into the educational communications picture could materially improve both the quality and quantity of education.

The local community, school, library or instructional materials center portion of a teleducation system may include several different media, and several different means of information distribution interconnections. A comprehensive teleducation system should be designed and specified to accommodate interconnections of subsystems with minimum cost, time and effort. In some instances, for economy reasons, one approach may cooperatively serve several other subsystems. Local subsystems may be interconnected with interstate, intrastate or intercontinental subsystems, thus opening up fantastic new horizons. Both flexibility and standardization are extremely important to such interconnections.

Some of the specific new equipment and new methods now available, or soon to become available, are discussed below:

A. A wide range of television and film pickup cameras is currently available, in color and black and white, for generating lesson sequences for studio, classroom, or outside portable work. In some instances local and systems service and maintenance are handled either by students or regular communications service stations on a contractual basis.

B. Some programs are transmitted live and on-line on real time to local classrooms or by distribution systems to other schools or areas, or even worldwide. In many cases programs are recorded and stored for later exchange and rental by recording and distribution libraries.

Most broadcast ETV stations have a wide selection of studio facilities, course production facilities, and video magnetic tape recorders available. Broadcast "compatible" recorders, generally in the $100,000 range, can handle tapes from other similar recorders in black and white or color, and on commercial broadcast channels.

C. Twenty or thirty different smaller (and lower cost) helical or slant-track video tape recorders in the $1,500 to $20,000 range are available for school and institutional use. These are sometimes compatible for playing tapes made on other recorders of the same model and make. Tapes, however, are not interchangeable or compatible between different models and makes or on FCC broadcast TV channels. There is no standardization of non-broadcast video tape recorders (VTR) in the U.S. Lack of interchangeability of tapes has long been a serious problem. Most VTRs are of reel-to-reel design now, and the Japanese, who make most of the existing slant-track helical units, have recently adopted an industry standard for certain classes of units.

D. The great fervor going on in VTR circles now is to come out with a new self-threading cassette or cartridge arrangement, mainly aimed at home use. New principles of recording are emerging, such as reductions in size and cost, and more convenience in use. CBS/Motorola, Cartridge TV, Inc. (Cartrivision), Avco Corporation, and Panasonic have already demonstrated automatic cartridge units in hopes of competing convenience-wise with the conventional record player. Some optimistic analysts predict a new cartridge VTR industry amounting to a billion dollars by 1980, and a dozen companies are working on different versions.

E. The CBS/Motorola electronic video recording (EVR) system is non-magnetic, but essentially a miniature photographic film approach where the film is "exposed" by an electronic beam controlled from a television type signal. It plays back with a television type signal through a conventional television receiver and closed circuit television (CCTV) system. The reel/cartridge is automatically self-threading and rewinding, about 7 inches in diameter and appears much like a conventional 7-inch reel for a home tape audio player. It will play twenty-five minutes in color or fifty minutes in black and white; it cannot, however, be used for local recording. A completely processed 16 mm. film or conventional VTR tape must be sent to CBS to be converted to EVR format. Since each reel contains about a quarter million images, future information/document storage and retrieval capabilities for information retrieval systems are forecast, as in the case of some slant-track applications. This unit is expected to be marketed by the fall of 1971.

F. RCA has a new and still different principle (SelectaVision) on the way, using laser beams and holography to play thirty minutes per cartridge. The holograph image is virtually indestructible, even if holes are punched in the film.

G. Japan's Sony and the U.S.'s AVCO expect their magnetic tape cartridges to play for over 100 minutes.

H. A new super 8 mm. film, German Nord Mende color vision unit for playing into a conventional TV receiver, is also on the way. A West German firm has developed a flat magnetic disc video unit that will run for fifteen minutes per disc; estimated prices are approximately $150 per unit and $2.50 per disc. This seems to be the lowest cost production in the non-reel-to-reel class designed for individual use and the nearest to the conventional record player in operation. If such units are developed for the home, they will most likely also be designed and marketed for school and institutional use. The CBS unit is already being promoted for education and training use at a cost of about $800 per unit and with cartridges in the $25 range.

I. Magnetic tape VTRs have great potential and considerable use in the educational technology field for recording and immediate playback, as well as for record-store-delay-replay modes.

The library or instructional materials center (IMC) for a school, community, school cooperative, etc., must soon be an electronic center also so that many forms of information retrieval and distribution, including electronic data processing, can be interconnected in the electronic wireline. A German development is said to permit electrical transmission of moving images over conventional local exchange telephone systems. Daily newspapers are now electronically set up via computer and simultaneously published coast to coast. Radio printers and facsimile now regularly transmit electronically printed matter and convert to printout copy from 1,000 to 10,000 words per minute. Telautograph and the "wired blackboard" have been in use for some time.

Some new developments in transmission and receiving methods and devices are discussed below:

A. Computer-assisted instruction (CAI) has been considered practical, effective and economical for some applications. The task remains to make CAI convenient and to train enough software instructors/

developers to handle the job. In the next year or so, one non-metropolitan computer location is expected to serve 10,000 students in public schools "on-line" via telephone lines.

B. Both audio and video random access systems have been on-line for some time at several locations throughout the country. At one university an audio random-access on-line system through which several hundred students receive lessons has been in use for several years. The voluntary student application rate has grown from 3,500 to 40,000 requests per week. When the content originates from well trained and well prepared teachers, the learner can progress as fast as he wishes—and seems to prefer the above method.

C. One high school is in the process of building a $2 million formal workhorse AV random access dial-up system. The system is designed to enable the audio "A" portion to extend to students' homes via the conventional telephone. A large city system is doing a similar experimental system for the handicapped (blind).

D. Wired blackboard course sequences have been tape recorded on conventional home and school tape recorders for later and repeated use. These tapes can be used for local library IMC or phone booth/carrel use, or for remote telephone lines connected to other schools. Such first-run live, on-line applications have been in regular use for some time in widely differing situations.

E. There is evidence that significant learning can result from non-real time, non-synchronous television presentations (a form of slow-scan TV). It is practical to transmit images over a conventional telephone line and to store the pictures on a conventional home or school audio tape recorder. The video images and audio can be stored on a conventional audio cartridge for later playback. This system has fantastic educational/electronics communication potential—it may easily become an automatic-dialed random access item. Between 200 and 300 such channels could be placed on one conventional ETV channel for multi-use broadcasting.

F. There is reasonable experimental evidence that two to four facsimile or radio printing multiplexed channels, simultaneously superimposed, can be transmitted on each conventional TV channel. These multiplexed printing channels could make much more electronic hard copy available for interlibrary or interschool applications, or to accompany television lectures.

G. Commercial multiplexing on FM radio has been standard FCC-authorized practice for several years. This means that each community and high school FM channel could be very economically used for carrying two audio and two narrow-band control or printing channels. This makes the small, low power educational FM station a valuable educational electronic resource for distributing educational materials and recordings electronically over the air to schools, instructional materials centers (IMC), or homes.

H. Just as we must have a library to organize, classify, store, and retrieve books and printed matter, now we must have the IMC to manage our non-book instructional materials. The magnitude of non-book information is becoming so great that the last formal non-book materials bibliography contract with the United States Office of Education was a nearly half-million dollar undertaking, and there are several such ongoing projects in the U.S.

I. Several computer-based wire and cable accessed information stores are available where 15 to 20 million documents can be stored, and where the desired coded abstract or document can be retrieved on-line and delivered to widely separated locations at the rate of five seconds per million reference items stored and searched. This has the potential to make an ideal statewide or institutional information management system once a statewide telecommunications knowledge network system is available to interconnect with such a modern electronic tool.

J. As these statewide telecommunications system networks become available, we can begin to make optimum use of multiplexing television and radio information channel subsystems. Several states have moved to statewide networks, and some twenty states have formal telecommunications networks in the planning stages.

K. An essential point in the trends in information management and distribution networks is that wider and wider channel band widths are necessary. Already the FCC has started 10 instead of 6 MHz conventional TV channel band widths in a special service. Many commercial closed circuit systems have already pushed far beyond this and, in addition, it has been suggested that some ETV and information-handling systems need two channel widths (12 MHz) to get needed detail and speed. As new services are added, as old services go to more interconnecting places, and as interconnections are consolidated in an information network, more communications space is needed. The more the coordination and consolidation, the more the unit message cost can be reduced. Without careful consolidation, insufficient channels will be available for desired flexibility.

L. By careful systems analysis and coordination, a most efficient arrangement can be developed. By including the largest area subsystems and needs, it is possible to design the best base system that will also serve statewide needs of other public agency systems and save more collective costs for the future.

Several different intersubsystem or inter-area primary distribution arrangements should be considered in a large state or multistate network:

1. One such primary distribution system approach is to lease from the common carrier systems, Bell Telephone, Western Union, etc.
2. Leasing from private microwave systems seems to be coming in strong all across the country for voice and data use.
3. Where there is enough traffic, the state can own and operate its own system and then interconnect between states. This has considerable flexibility and economy potential.
4. Another method depends upon the growth of wide-band CATV Cablevision, if the application becomes nationwide as many predict.
5. Using the domestic telecommunications satellites, intracontinental as well as intercontinental seem to be growing into great favor with indications of significant savings.
6. Many various combinations of the above also seem quite possible.

Some modifications and refinements appear possible to convert some of these devices and approaches to additional functions to extend the features of an available total distribution system base. For example, some operating subsystems have converted a helical slant-track recorder to "still play" (to show one frame track at a time) one desired video picture document which might be selected from perhaps a quarter million documents on that reel of tape. This has great potential for documented storage and retrieval. By combining this mode with accompanying audio retrievals and a computer, one could computer program lesson sequences for programmed learning—a form of CAI—from remote line interconnected locations or for random access systems. Both applications could have great significance for statewide library information management as a part of a statewide educational information network.

In the past because too few channels have been available and because of costs, most of the educational communications applications have been one way to the student, although many were nevertheless reasonably successful. With better combined systems design and more multiplexing means for finding new channels, it may be possible to add many more student response channels than could previously be accommodated. As some elements of the curriculum go to more and more people, and as the overall network is expanded, the situation soon occurs where there is not time for all responders to get back to the teaching source (when it is real time). When recordings are used, this response must be handled in other ways. Low-level two-way communication is very desirable when people and time permit.

Enough examples of both potential and problems have been shown to indicate the immensity of the systems, the operational engineering and the software awareness necessary to make innovative educational approaches function. These approaches must realize some of the signs of the times: an unmistakable trend in the direction of the communications/electronic culture and the concomitant problem of the relevancy and expectations revolutions. If a base system were now available, more specific proposals and suggestions could be made. When communications technology and education get together and sufficiently understand each other, they will discover that each can aid the other in great measure to bring educational advantages to many more learners, a must if education is to cope with the communications/expectations revolution.

Nothing on the educational horizon has such great potential to help our educational system as the application of the already known communications technology techniques of two-way information handling and dissemination. No single sector of our economy, outside national security in wartime, could become a larger consumer of communications technology than the educational sector, and no sector needs it more. Even so, nothing much will happen if these sectors do not understand each other's language, needs, and problems.

Reference

1. U.S. Congress. Joint Economic Committee. Subcommittee on Economic Progress. *Automation and Technology in Education; A Report.* Washington, D.C., U.S.G.P.O., 1966.