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ABSTRACT

This paper attempts to describe the advantages of "narrow-band" applications of communications satellites for education. It begins by discussing the general controversy surrounding the use of satellites in education, by placing the concern within the larger context of the general debate over the uses of new technologies in education, and by challenging educators to harness the enormous power of satellite communications for both formal and non-formal educational goals and objectives. It proceeds to analyze the differences between narrow-band and broad-band technologies, and raises questions concerning the educational value for using broadcast television in the classroom, whether delivered via satellite or through terrestrial means. The development of "Open Learning" and non-traditional study programs is cited and discussed, along with the explosive growth of Citizens' Band radio, as examples of ways inexpensive and narrow-band technology can serve changing educational needs and requirements. A variety of narrow-band applications are then offered: Telephony, radio, slow-scan television, data and hard-copy, telex and facsimile, cable radio. A systems view is presented, as are some cost considerations. The paper concludes with the strong recommendation that educators assume a lead role in de-mystifying satellite technology. (Author)

NARROW-BAND APPLICATIONS OF COMMUNICATIONS SATELLITES

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ABSTRACT

This paper attempts to describe the advantages of "narrow-band" applications of communications satellites for education. It begins by discussing the general controversy surrounding the use of satellites in education, by placing the concern within the larger context of the general debate over the uses of new technologies in education, and by challenging educators to harness the enormous power of satellite communications for both formal and non-formal educational goals and objectives.

It proceeds to analyze the differences between narrow-band and broad-band technologies, and raises questions concerning the educational value for using broadcast television in the classroom, whether delivered via satellite or through terrestrial means.

A broad definition of education is offered, in which education is viewed as an exchange (a two-way flow) of information, or the communication that takes place within a society. The development of "Open Learning" and non-traditional study programs is cited and discussed, along with the explosive growth of Citizens' Band radio, as examples of ways inexpensive and narrow-band technology can serve changing educational needs and requirements.

A variety of narrow-band applications are then offered: Telephony, radio, slow-scan television, data and hard-copy, telex and facsimile, cable radio. A systems view is presented, as are some cost considerations.

The paper concludes with the strong recommendation that educators assume a lead role in de-mystifying satellite technology.

STATEMENT OF OBJECTIVES

The prime objective of this paper is to provide educators, and regional and state educational organizations, with a perspective on the possibilities inherent in the narrow-band applications of satellite technology.

It seeks to provide some background about the current state-of-the-art, and to indicate what may be possible in the near future as satellite technology develops.

In order for educators to take fullest advantage of a satellite's information-carrying potential, the paper defines education in extremely broad terms. It also attempts to point out that the current tendency in American education is towards a new openness, towards a definition which is beginning to view education as a process of human development requiring no fixed methodology.

The paper seeks, as well, to place before the educational community a series of options, some possible experiments that might fit within the National Institute of Education's proposed four-year program concerning the use of satellites in education.

It also attempts to argue that satellites seem to represent a powerful educational tool, despite the well-grounded fears that are known to exist both within and outside educational circles. One objective is to offer a convincing argument that satellite technology can be controlled, and that educators and educational institutions have a major role to play in harnessing it to serve human needs.

FOREWORD

In considering the use of satellites for education, we approach a subject swamped in controversy. While it possesses its own peculiar history and unique cast, space communications is merely part of a much larger, wider-ranging debate concerning the function and purpose of American education. This is a time of shifting student populations, changing educational requirements, dwindling budgets, rising costs, increased minority and other student demands for increasingly scarce resources, and consumerism. It is also a time when the school no longer competes only with the family, the peer group, the workplace, and the church for the rapt attention of young, and now adult, minds. To these have been added an ubiquitious technological jungle of electronic sight and sound, replete with pocket-sized transistor radios, wall-to-wall quadraphonic components, battery-operated tv Portapaks, hand-held Walkie-Talkies, and, of course, Television. Nor, as recent experience has taught us, can these electronic modes of "learning" and "teaching" easily be made to fit within established educational methodologies and practices.

Unlike the family, whose potential threat to the autonomy of the teacher was effectively channeled long ago into such efforts as Parent/Teacher Associations and adult education programs -- or the parochial schools, which have carved out for themselves a comfortable arms-length relationship vis-a-vis

the public curricula -- the electronic media have gone beyond the neutral zone. Over the years, they have moved with increasing force into every sphere of individual and community life; now, they have begun to move squarely into school-life itself, bringing with them a host of new (and often times hidden) agendas, conflicting demands, added costs, and an alien technical jargon. Their combined effect has had an unsettling, certainly disorienting, impact upon administrators, teachers, students, and parents alike.

We would be less then candid if we did not state at the outset our fear that the communications satellite, too, may well be received in much the same light. Unless it can be made totally subordinate to the educator's requirements, capabilities, and goals, its future may well parallel earlier technologies that are now locked away in storerooms to gather dust and reap scorn for their inappropriateness. We see nothing new here, except the technology; or, as Albert Einstein once put it concerning the potential impact of new technologies, "Everything has changed, except the mind of man." Einstein's remark reputedly was made in the context of the development of the atomic bomb, but there are some who believe that the potential harm to come from space communications may be just as great. According to Dr. Carroll V. Newsom (retired Vice-President for Education at RCA, formerly President of New York University, and the current Chairman of the Board of the Guggenheim Memorial Foundation), with satellites, "Again we find ourselves dealing

with a situation, so common in modern times wherein technology has outrun man's true understanding of its potential, often potentially disastrous, effects on a society." [1]

We grant the "potential for disaster;" it is undeniable. The intention here is to alert the educational community to the dangers; to explore ways they can be averted; to examine how satellites -- and what applications of satellite technology -- can help revitalize, decentralize, innovate, and improve generally the educational process, both as it takes place within and outside of the classroom. The purpose will be to assess what is available; to consider what is possible; to encourage the kind of sound research that can only be done by redressing the imbalance of research and development funds allocated to technological rather than educational objectives; and to promote informed public discussion of the issues and the options.

INTRODUCTION

This opportunity to consider the advantages of "narrow-band" applications of communications satellites could not come at a more propitious nor more appropriate time. It is not only the educator's appetite for the technology that has been whetted. The whole society has begun to discover satellites, and seems awed by their enormous potential for transforming on a global scale the way information is gathered and disseminated. If anything, the educational community is arriving on the satellite scene at a rather late date so far as the technical design and engineering parameters of the current technology are concerned. The Pentagon, for instance, has been using satellites over the past 15 years to provide a central command-and-control network, interconnecting U.S. Military bases and personnel around the world. There already exists an international, commercial, satellite telecommunications network (INTELSAT) serving constituencies in business and government that require full-time, global telephone, telex, data, radio and television links. More recently, the use of satellites for commerce here at home has begun to take root. Indeed, the business of satellites has just begun.

Since this paper is not to recapitulate this history, it is assumed that readers have some knowledge of the subject. It is also assumed that there exists a familiarity with the recent experiments with newer satellite technologies for the

delivery of social services: the health, education and telecommunications experiments conducted in 1974 and 1975 on NASA's ATS-6 satellite in Alaska, Appalachia, and the Rocky Mountain States region; the ATS-6 experiments now taking place in India to provide agricultural, family planning, and other educational TV programming to villages equipped with low-cost satellite ground receivers; and the recent launch of the joint NASA/Canadian experimental Communications Technology Satellite, by far the most powerful communications satellite ever designed to transmit TV, radio, facsimile and telephone signals to extremely small, relatively inexpensive earth terminals. Beyond this, it is assumed that there is a general understanding of the history and practice of educational broadcasting as it has evolved in the United States, of the differences between the use of satellites and terrestrial networks, and of how these differences can be measured in terms of a satellite's ability to increase channel capacity, eliminate distance as a factor of cost, and reach into remote areas where adequate and reliable means of long-distance communications may not exist.

Finally, it should be understood that this paper will discuss satellites and satellite configurations that do not yet exist, or exist only in an experimental mode. The overriding concern is to demonstrate to the educational community, to the regulators and policy-makers in Washington and elsewhere, that satellites, if wisely applied, can have an important part to play in the future of American education. The concern (like the

caveat) is hardly academic. A concerted effort will be required to ensure that future generations of satellites are technically designed in such a way to best serve the needs and interests of educators. The technology, contrary to much prevailing thought, is not neutral.

Although it also has been suggested that the reader not be bogged down with a nuts-and-bolts discussion of the technology, consideration of certain technical matters cannot be avoided. Indeed, some understanding of the technology's engineering parameters will be absolutely essential if educators are to make sound, reasoned judgments about how their scarce resources might best be invested to achieve the greatest educational return from satellite communications.* And, to no small degree, the authors believe that their bias in favor of "narrow-band" applications of satellites can best be evaluated by the technically informed. Just as there are different kinds of automobiles, there are different kinds of satellites. The world of space technology, too, is comprised of Volkswagons and Cadillacs, economy packages and deluxe models -- each designed to fit a particular class of user, to serve a unique set of communications requirements. The educational community's prime task will not only be to make the right choice -- but to make it on the basis of what it knows its needs to be, and not on the basis of what someone else tries to tell it they should be.

* By no means do we mean to imply that any classical "cost-benefit" analysis can be applied to education. On the contrary, the authors' view is that the human benefits of education cannot be evaluated in quantitative terms.

Matching the Technology to the Need ~~Advantages of Broad-Band~~

The principal technical point concerns a satellite's information-carrying capabilities, which are limited. Today's versions, and those planned for the near future, have been designed to carry between 12 and 24 channels, called transponders, each of which can handle either a single, one-way, "broad-band" (e.g., television) signal or about 7,000 two-way "narrow-band" circuits (e.g., telephone, telex, data, facsimile, radio and slow-scan television).[3] Beyond the fact that use of a satellite to deliver color television requires a disproportionately large portion of spectrum space (what Mr. Marcel Thue, Chairman of the French Frequency Committee, has called an increasingly scarce natural resource "that should be treated as a permanent, but limited, natural resource like water"),[4] it can be enormously expensive. While it's too early to know what the actual dollar figures will be, the laws of physics indicate that they may be many hundreds of times as costly as sending a single, two-way, audio signal. Nor will the higher costs be felt only in the satellite. The costs for ground equipment required to transmit and receive broad-band rather than narrow-band signals will also be considerably higher, although here again cost-factors are big unknowns, since such expenditures will be a direct function of the number of units manufactured and sold.

[3] The term "broad-band" refers to the bandwidth necessary to carry a color TV channel, which consumes some 5,000,000 Hertz (6 Megahertz) of spectrum space and requires a great deal of transmitting power in a satellite. The term "narrow-band," on the other hand, refers to the bandwidth required to carry the equivalent of high-fidelity radio (15,000 Hertz, or 15 KiloHertz) and on down to the lesser spectrum requirements to handle such services as telephone, telex, facsimile, data, and slow-scan TV.

Added to the higher costs is an ascending hierarchy of problems associated with broad-band satellite applications. At the base of them is the complex and relatively inflexible nature of not only the equipment required, but the way it is generally managed and controlled as well. Cameras, monitors, video-tape recorders, all costly devices, can usually be used only on a shared basis. Anyone who remembers the Mid-West Airborne Television Instruction Project, and, indeed, even some of the recent experiences with the use of television on the ATS-6, knows of the turmoil that can arise when the intense, patterned activity of the school is disrupted by new requirements imposed by technology. Changes in class schedules (including changes in lunch hours for students and teachers), maintenance, getting individual school districts to accept a common curriculum, and the juggling of staff assignments are always headaches. But, as was observed time and again with ~~the ATS-6~~ Post experiments, they can be minor inconveniences compared to a teacher's frustration in trying to contend with television's continuous one-way flow of programming directed at variously puzzled, disinterested, bored, and restless children.

Serious questions can be raised about the educational value of using satellites to deliver television. In a recent editorial ~~that appeared in Educational Broadcasting International~~, Mr. Tom Singleton, the internationally known British educator and broadcaster, had this to say on the subject:

> So far there is no hard evidence to support the case for the use of satellites in the provision of educational programming. There is, however, a considerable body of evidence which gives a clear indication that television instructional programmes do not teach

> effectively unless they can be recorded from transmission and used by, and when, the teacher in the classroom situation wishes. But this concept of recording in real-time, off-air, presupposes further massive expenditures on capital equipment such as video recorders, maintenance units and tape libraries...3

Mr. Singleton is quoted because he represents a growing community of opinion which says that "...Variation in learning is more dependent on how a medium is used rather than which one is used."[4] More and more, the communications research community is adopting a cautious, more realistic appraisal of television's appropriateness in the classroom. The advice of the U.S. Surgeon General's 1972 report on televison, which suggests that the point may not be for children to watch better television, but for them to watch less, should also not escape the attention of educators. According to the report, the child who watches televison

> has no opportunity to ask questions of those he sees on the screen. He has no need to plan what he will do next, or how he will carry out his plan of action. There is no way he can change the pace of the action on television or divert the inexorable unfolding of events before him. Whether he smiles or frowns, whether he looks puzzled or enlightened, whether he shows amusement or fright, whether he approves or disapproves, the events roll on. 5

These words, as well as the five volumes of research upon which they are based, turn upside down McLuhan's once-popular cliche, "The medium is the message." How should the purported educational value of television's in-school use be viewed if an end result of the medium may be to encourage regimentation and passivity in the student population?

Obviously, this is not the place to unravel, debate, or elaborate upon the implications of this problem. Suffice it to say that the pervasiveness of television, its ability to distort reality while appearing "true-to'life," and its addictive effect upon the viewer are problems that are well known to extend beyond the confines of the classroom; children, while they may be more susceptible, are no less affected by television's influence upon the mind than are their parents and, indeed, their teachers.

All this is not to say that there is no future role for television in education, provided it (like the telephone) can be made more responsive to the needs of the user -- and, indeed, that decisions made concerning its content can be located more and more in the hands of the user. It does, though, raise serious questions concerning what may be the educational consequence of promoting the use of satellites to extend the reach and impact of television in its present form, despite the fact that this is precisely what a satellite is quite capable of doing.

Satellite communications are ideally suited to the development of a national system of educational television, which in turn could lead to a federal curricula. Such a development, though, should be forced to stand the test of thorough scrutiny, of open public discussion and debate, and be evaluated in light of the probable impact it would have upon the traditions and current practices of American education. One wonders, for

instance, whether the concept of the "neighborhood school" itself would not be dealt a final death blow by the "electronic teacher in the sky?" While there are many who fear it, there are just as many, within and outside the educational community, that would welcome it. (Indeed, there are signs that such an effort is now being conducted by the Corporation for Public Broadcasting, which intends to launch a $40 million satellite-based educational network by 1978.)[6]

The chief purpose here is not to debate the pros and cons of moving in this direction, but to offer alternatives to it -- ones that may fall more in line with the growing movement in education today that favors the development of a more open learning environment, a two-way rather than one-way information flow, simpler and less costly technology applied to education, a less centralized structure of control, and a broadly-based curricula aimed at helping students (young and old, in-school and out) play a more active role in their social and community life.

Toward A Broad View of Education

How should education be defined in the context of satellite communications? Answering this question need not require turning our backs upon traditional, earth-bound concepts. On the contrary, dictionary definitions themselves seem perfectly suitable. One describes education as "The systematic instruction, schooling or training given to the young in preparation for the

work of life; by extension, similar instruction or training obtained in adult age." This is the third of several definitions offered by the Compact Edition of the Oxford English Dictionary. The first, however, defines education more broadly, as "The process of nourishing or rearing a child or young person." What is appealing about the latter is that it deals with education as a process of human development requiring no formal methodology, no structured curricula, and, no fixed location wherein it must take place. To be sure, education involves the formal instruction of such classical subjects as "reading, writing and arithmetic." But it also deals with the exploration of ways of living, the teaching of vocational skills and survival techniques, the sum total of information required to comprehend and cope with the demands of one's life and times.

In this sense, education can be viewed as an exchange (a two-way flow) of information, or the communication that takes place within a society. The exchange may occur between individuals, within or among organizations, or between organizations and individuals. Most "education" today goes on in this fashion, with people joining organizations (e.g., a school, a social club, a fraternal organization, a political party, a community radio station) that not only facilitate the exchange of information among their members but, by forming networks of communication with others, encourage the development of information links with other groups. Acceptance of this enlarged

view of education is evidenced by the growth of "open learning systems" that have begun to spring up across the country under the auspices even of traditional institutions of higher learning. Such new programs as the University of Mid-America, The Empire State College, and The University Without Walls are currently offering a wide range of nontraditional courses, often via such nontraditional means as television, radio, computers, and the telephone.[7] This all relates directly to the potential of satellite technology, both in a technological sense (i.e., improved, cheaper, and more accessible means of information exchange) and in the sense that traditional methods of acquiring education are being altered in the direction of a new openness.

Another case in point of how the lines between education, information, and new technologies have been blurred can be found in a recent communications phonemenon: the explosive growth of Citizen's Band radio.* Given access to communications at a reasonable price, using a narrow-band technology, people will seek ways to use it for what they believe are their "educational" needs. There may be some legitimate argument over the educational value of being able to inform a fellow truck driver of the exact location of a police radar patrol; it can hardly be considered "formal" education. Yet, to the truck driver it has become an important tool for keeping in touch with, and

* Since 1970, the number of people licensed to own and operate CB radio gear has proliferated from less than 500,000 to well over 5 million. And no one knows how many are using this service sans license.

coping with the demands of, his world. The issue gets softer (and the argument against it weaker) if one considers the truck driver's use of C.B. to help someone in trouble along the side of a highway; or when it is used to exchange what may be life-saving information. Our society seems to be leaning more and more toward a concept of education that is based upon what the participant -- the consumer -- wants and needs.*

While this trend is too well-known to educators to dwell on at great length, it can precipitate blistery debates about formal vs. nonformal, in-school vs. out-of-school, and traditional vs. nontraditional education capable of generating as much heat as light. The reason for making reference to it at all, is that it cannot be avoided. The newer electronic information technologies, if they are not closely examined by educators and if careful attention is not paid to how they can best be integrated within established practices and traditions of American education, may well erode much that is worth preserving. The flood and availability of this hardware, which is closing the gap between education and communications, is bringing us ever closer to that edge-of-the-world point for educational traditionalists where the consumer makes up her or his

* It is also worth noting the increasing acceptance, in educational and other circles, of audio cassette tape. Much money is being spent to promote its use in automobiles and elsewhere as a learning tool. If the idea of the automobile as classroom makes sense, why not accept, from the users' point of view, the use of C.B. as an educational medium?

own mind. If the United Farm Workers Union, the National Organization of Women, or the League of Women Voters view communication with their membership as part of their "educational" mission, they are merely following the example set by General Motors, which regards its annual new car showing to salesmen via closed-circuit television as education.

Educational concepts, like schools and technology, are changing. If the school is to continue to play a key role in this changing educational ambience, it too must be prepared to continue to adapt. More and more, educational institutions are making strong efforts to keep pace by seeking "outreach" to the communities they serve, both in a physical and social sense. Rather than being viewed as a threat, the newer technologies should be viewed as an opportunity to extend this process. They can serve as powerful catalysts to bring individuals, organizations and educators closer together to collectively consider ways the school truly can become a community resource for the exchange of information, to become a community information center in the broadest sense. Such an effort may best be achieved by taking advantage of narrow-band communications techniques, since they can bring the same kinds of values into education that have prompted citizens (of all ages) to seize upon -- and to use -- Citizen's Band radio and other low-cost communications technologies.

NARROW-BAND APPLICATIONS

Background

While the discussion of narrow-band applications of satellites that follows is premised upon the broad definition of education offered above -- which, of course, concerns the educational communication needs and requirements of all segments of the nonprofit sector -- it will be directed largely to those who operate within the "traditional" sphere of education. It is recognized that this is the audience for this paper; in turn, it should be understood that the possibilities presented can just as easily be applied to other nonprofit groups in society that provide a wide range of social delivery services or otherwise operate their own (albeit bare-bones) informational exchange networks.

It also should be pointed out that the services discussed are not new. They have been deployed for years by corporations and government entities able to afford the use of narrow-band telecommunications services, ranging from WATS-lines, facsimile and telex techniques, Mailgrams, conference calls, radio networking, and on up to computer terminals. Many of the techniques to be considered, and the way they can be joined to satellite communications, are known to the educational community. Anyone familiar with the PEACESAT (Pan-Pacific Education and Communication Experiments using Satellites) program in the Pacific Basin is aware of the enormous potential they offer for

education and community development. The PEACESAT experiments, which began in 1971, currently interconnect 15 educational institutions in 12 countries scattered throughout the South Pacific via an "old" NASA satellite (the ATS-1, launched in 1966) for the exchange of news, education and other information relevant to the development of the region. Its accomplishments, which include the development of extremely low-cost satellite ground equipment, are far too numerous to be considered here. Suffice it to say this project has dramatically demonstrated the educational value of deploying narrow-band techniques for two-way, user-controlled, needs-oriented communications, via satellite.[8]

In terms of the options educators may want to explore for obtaining access to an existing or planned satellite, various possibilities exist. The use of commercial satellite carriers (either those presently in the business or those planning to get into it) should not be ruled out. Indeed, this may become a viable route presuming the costs can be made managable, perhaps through the establishment of special tariffs for non-profit users or some other measure. But any lengthy discussion of this at the moment would lead to some rather dark and murky areas of cost-comparison; and into a technological realm which, as was mentioned earlier, still contains many unknowns. Among other things, it would be necessary to compare techniques, tariffs, and prices that are only beginning to emerge against a system of satellite communications that does not yet exist, despite

the fact that cause for optimism on the part of the educational community may not be far away.

The Canadian Communications Technology Satellite (CTS) is proof that the kind of low-cost satellite technology that could greatly benefit the potential educational and narrow-band user is just around the corner. The CTS is currently testing the transmission of broadcast signals to three-foot diameter dish antennae. Moreover, this new satellite, which possesses far greater transmitting power than the ATS-6, is capable of sending radio and telephony to even smaller ground receivers which, when mass produced, may cost as little as a few hundred dollars. By 1980, the Canadian Government intends to install this kind of technology as part of a nation-wide, full-scale operational satellite system, serving more than 500,000 homes and offices. A new day in communications from outer space may be fast approaching.

Telephony

The key to the educational utilization of satellite technology lies in answering the question, what would educators like to accomplish with a device that is cost-insensitive to distance and can reach into remote and inaccessible locations, including "isolated" urban areas? At the very least, long-distance telephone expenditures could be drastically reduced. This may be of lesser importance in formal rather than to non-formal educational situations, but it is suspected that schools,

and certainly school systems, spend a great deal of money communicating long-distance by telephone. In the case of telephone traffic between state education departments and isolated, rural areas, this likely amounts to a surprisingly large sum per annum.

To realize this potential, educators need not restrict their vision to future generations of satellites. A great deal of long-distance telephony is beginning to move over existing commercial satellites; the issue is one of rates. A strong argument can be made, for a nonprofit tariff on all existing (and future-planned) satellites for educational entities, although it is a policy matter that will have to be considered by regulatory agencies.

There are other considerations beyond the cost of telephones as used within educational systems. Teleconferencing arrangements, which are being used in a variety of educational systems today, are limited by the number of points that can be interconnected at any one time; the telephone company, for instance, can hook up a maximum of only 30 locations. A satellite can allow for the simultaneous interconnection of any number desired. It can also be used as part of a direct dial system to permit students access to a variety of tutorial aids, such as is used by The Open University of Great Britain.[9] One way such a system could be used is for the student to phone in to a tape-recording device which contains the answers to the most often-asked questions about some specific lesson material.

Should a student need further explanation of the subject, tutors may be reached at their offices or homes at specified times. It would be quite simple to route this kind of educational traffic via satellite, and, since the costs of using a satellite is insensitive to distance, a tape recording or a teacher could be located anywhere.

Radio

Another application is radio. There are a great many high school, college, and university owned and operated radio stations. Some are used for specific instructional purposes, others for general enrichment, while a few are only seen as student "playthings." All of these have value for providing either formal or nonformal education to audiences both in and out-of-school. An interconnection of many (or all) via satellite could allow for an interchange of ideas, for the exchange of well-produced programs in one locale (perhaps by virtue of the presence of an especially gifted teacher or expert in a specific subject) with other schools, in other localities. It is not necessary here to specify what kind of material would be shared; the menu is too rich and varied, and educators will have to make determinations about content in terms of their own local needs and interests.

The satellite's capability to provide programs to and from (and "from" is seen as especially important) remote areas provides another dimension. For the most part, people in these

locales lack the choices of specialized subjects that are available where there are large concentrations of students and where, therefore, the cost/per/student for specialized services can be justified. In such areas as Native American reservations, prisons, migrant-worker camps and rural health clinics, the problem is as much one of isolation as it is a lack of information. Radio, via satellite, can close some of these gaps, subject, of course, to the caveat that satellite technology be allowed to develop in increasingly low-cost modes.

A marriage of satellites and radio offers a potential that could extend well beyond any of this. It could achieve an early dream of Major Edwin Howard Armstrong, the inventor of FM-radio, by laying the ground-work for the development of a truly national, high-quality, high-fidelity FM radio network. Such a network could evolve in any number of ways with the assistance of the educational community. For instance, high-school and college stations, in addition to being linked among themselves, could be interconnected with the growing number of non-commercial, largely listener-supported and community-based FM radio station that have sprung up across the country over the years. Not only could a network of this kind be used further to expand the exchange of programming among station, as was suggested earlier. It could also help re-establish an on-going dialogue between educational institutions, community groups and others concerned with discovering new ways of bridging the gap between school and community life.

While an appropriate structure and management system obviously would have to be established to oversee the network -- to establish general rules of access to it, to formulate criteria for the kinds of programs that would be produced for it, to arrange for such matters as scheduling and distribution -- the effort may well be worth serious thought and evaluation. Its educational pay-off could be great in terms of motivating students, teachers, parents and other community members to come to grips with the educational potential of satellite-radio networking. By way of illustration, the system could be used to deliver programming to audiences that for one reason or another are inadequately served by existing radio networks (both commercial and non-commercial). Consider, for example, how it could be used to provide public affairs programs and in-depth news coverage to the blind and visually handicapped, who have no viable way of keeping up with current news and events. To make up for this lack, there could be imagined a daily (or weekly) broadcast of columists and commentators presenting as many sides of a given issue as possible. Such broadcasts could also include information of specific interest to the blind: news about products, services, publications, tools, survival skills, etc. The potential of using a satellite for this purpose could just as easily be expanded to meet the informational needs of a wide variety of other audiences, such as prisoners, juvenile delinquents, alcoholics, drug addicts, and children enrolled in "specialized" education programs.

Slow-Scan Television

A valuable adjunct to radio and telephony -- and which lends itself well to satellite transmission -- is slow-scan television. This technique allows a black-and-white picture to "build-up" on a television screen which, in at least one system known to the authors,[10] can be accompanied with a simultaneous audio narration. The signal, which passes through a small converter, can display a visual image on an ordinary television monitor which, in turn, can be photographed with a Polaroid camera if a hard-copy version is desired for future use. Both the image and the audio portion can be recorded for future play-back by connecting an ordinary audio tape cassette recorder to the system. Because slow-scan is sparing of bandwidth (it requires only 3,000 Hertz of spectrum -- like a telephone circuit -- to deliver one picture per minute, and only 15,000 Hertz -- the requirement for FM radio broadcasting -- to receive a new picture every ten seconds), its costs of transmission are minimal. Its delivery via satellite offers some exciting educational opportunities.

For one thing, because the system can be battery-operated and therefore made portable, it can be used to bridge the gap that tends to exist today in education between field- and classroom-work. For example, a student (or team of students) sent out to investigate a particular event or subject could record it on the portable slow-scan equipment for later distribution via satellite; or, the material could be sent "live" if an

ordinary telephone is on the scene and can be hooked via conventional phone lines to a satellite's transmit point. Used in this way, the union of slow-scan and satellites can be seen leading to, among other things, the development of a student-managed educational archive, which could be used to catalogue and record events deemed valuable by students and which could be accessed on demand by schools plugged into the network. It also could be used to unite students across the country in the pursuit of more formal educational objectives: A geology class in the Southwest could be put into direct audio/visual contact with a team of professional geologists exploring rock formations in the Northeast; marine biologists in Macapuu, Hawaii could share their latest research findings with colleagues in Woods Hole, Massachusetts. Because the costs of the system would be low, its usage could be high. And, if the thought of transmitting black-and-white "still" pictures seems old-fashioned or unglamorous, educators would do well to consider recent research indicating that both color and motion may retard a student's ability both to comprehend and retain information.[11]

Slow-scan also lends itself to a variety of non-formal educational situations worth mentioning. Earlier the isolation of life on Native American reservations was discussed. Some combination of telephony and slow-scan could link together, for instance, the grandparents, parents, and

siblings of Native Americans who have stayed on the reservations with those who have entered into urban life. The same, of course, could be done to connect members of other ethnic groups who are isolated from either their peers or from the urban or the rural situation. A system of this sort could provide two-way communication: information need not only be transmitted to those in the isolated settings, but from them to those who have left the locale yet still wish to share in the stream of educational and other information that is generated "back home."

Data and Hard Copy

A satellite can transmit virtually anything that can be either reduced to an electronic pulse or placed on an electronic carrier. This leads to some thoughts about its potential for both data and hard-copy exchanges. In addition to what may emerge as a surprisingly large use of telephones throughout an educational system, a great deal of paper also tends to get "pushed through." There are often advantages to moving paper (and data) quickly, and problems are increasingly encountered not only in moving it to and from remote locations, but between and within urban centers as well.

There are other possibilities: hospitals and health care systems could be interconnected, both for improving the quality of medical (or paramedical) education, for diagnosis, or for improving medical record-keeping, a matter seen as important in a country whose population is as much "on the move" as our own. The value of a medical information system of this sort was demonstrated during the Alaskan experiments with the ATS-6, where health "care-takers" of Eskimos and Native Americans made wide use of the system. While one could implement a system wherein individuals carried their own medical records, a far more effective and probably more efficient system would be one in which medical records, including diagnoses and prescribed treatments, would be kept in a central data bank and could be accessed by a health-care institution, via a satellite interconnection,

It has often been suggested that one way of looking at a satellite is to view it as a substitute for the costs of travel. From the perspective of a school administrator in a large area with remote locations, it may be possible to envision it in such a manner. If, for example, the school system is already providing a materials distribution service via a "range-riding" audio/visual utilization teacher or staff, a satellite could be substituted as a distribution mechanism, as was done in the Rocky Mountain States with the use of the ATS-6. Given the increasingly poor performance of the postal service as a means of delivering material, a system of this sort might well be cost-effective.

Telex and Facsimile

A number of innovative applications could emerge by joining telex and facsimile techniques with satellites. One obvious use would be to improve the state of journalism as it is practiced in schools. High-school and college newspapers are carriers of both information and material of educational content, although much of what they carry is generally highly local in nature. Such papers could be linked and cross-linked, high-school to high-school, college to college, and each to the other. The linkage could be via a satellite-based network using telex, slow-scan, or facsimile devices currently available on the commercial market. (Even elementary schools could participate in this news and information exchange network.)

Such a network could operate in a far more timely and less expensive manner than anything that now exists.

A system of this kind could do more than merely provide for the exchange of information. It might be used, for instance, to transmit facsimile copy to remotely located printing plants (i.e., school), just as the Wall Street Journal now does in order both to increase its distribution and to reduce its printing costs. In the end, this could result in the development of a variety of national, student-produced and circulated newspapers and news-services.

Some might see a "downside risk" if the printing process is considered an important educational objective for those working on school papers. But, to offset such fears, there seems to be definite and positive educational value to be achieved by allowing students (especially those planning careers in printing or journalism) to have hands-on experience with the very techniques that are being developed by the industry they intend to enter.

Cable Radio

One system which has been used, but certainly not to its fullest extent, is cable. Little known is the fact that the first cable system in the United States was to improve radio reception. Most cable systems do have surplus capacity; moreover, most tend to cluster in tertiary (remote) markets where they were originally built to improve the reception of

television signals. This raises the possibility of using the audio channels (which, in many cases, are specifically allocated for either education or other public service use, and which can be modified with little effort to operate in a two-way mode) and interconnecting them via satellite. The prospect of linking satellites and cable seems bright for the exchange of education and information between a Native American reservation, a coal mining town, a remote location, and a large urban center.

Using an existing cable system as part of the ground-based link for home or school delivery also offers considerable economic advantages, since only a single satellite transmit-receive unit would be required to service an entire community (or geographical area). One innovative use of cable along these lines involves an experiment being conducted in 37 schools in the Copper County Intermediate School District in Michigan. Instead of using a satellite (none exists) to carry an audio signal to a cable head-end, however, the School District is making use of a local FM radio station's sideband signal to deliver the message to the cable operator which, in turn, sends it out to the schools. Of further interest is the way the system has been adapted to deliver slow-scan television.

Thinking Big with Things Small: A System View

What seems of value to the would-be experimenter is the importance of keeping an open mind to potential narrow-band uses. They could be of real value, despite the surface

attractiveness of other technologies, like slickly-produced color motion pictures. Slickness may not be best suited for those in isolated and remote areas, where audiences may require something quite different. User needs should "drive" the system, not the technology nor the production techniques.

In this regard, reference was earlier made to the increasing desire of educational institutions to "reach out" into their geographical and "service" communities. This phenomenon is well known to be on the increase, despite the fact that it seems to exist largely on a community-wide rather than nationwide basis. Perhaps it makes sense to suggest, and at this stage it is a hypothesis which needs a great deal more research, that interconnecting institutions engaged in this process, via satellite links, may be of value.

In effect, existing educational institutions, which are already serving as community education and information exchange centers, could be transformed into communications centers. What might such a center look like? It would likely contain, among other things, a satellite radio transmitter and receiver, a computer access terminal, slow-scan TV system, and associated recording equipment. What function would it serve? It could permit a wide variety and number of people to share the use and services of a single institution that could be connected to -- and accessed by -- other people and other institutions.

There seems no way of predicting at this point what kind of data would be exchanged. It might vary from requests for

hard copies of books and other materials (including unpublished theses) to "rap" sessions about mutual institutional and educational problems. (It is known, from the ATS-6 experiments, that a great deal of administrative communications interchange took place between cooperating institutions; it was felt to be an extremely valuable process by those involved.)

As experience with such a system develops, both with the technology involved and with the process, other needs and uses will undoubtedly surface. The main point is that there seems to be a way, via satellite, to extend and strengthen an already ongoing movement. Some experimentation along these lines might be worth encouraging.

Some Cost Considerations

No specific costs can be provided from the level of generalizations contained in this paper. Fiscal matters must be carefully considered on the local level, taking into account such inputs as salaries, transportation, availability or capital cost of equipment, current uses of audio-visual and other materials -- and needs. And, of course, any kind of analysis must consider the costs (and cost-effectiveness) of using a system for only a single purpose. The total expenditure should be viewed as a function of the totality of uses wanted within an educational system which may reduce what otherwise may be misleading figures. If there is a need to transmit telephone messages, radio, data and hard-copy within a system, or for

computer assisted or computer managed instruction, the costs of using a satellite may be within reach.

Cost comparisons can be invidious, both for some of the reasons already suggested and because of the folk-wisdom about the difficulties of comparing apples and oranges. The question for educators contemplating the use of satellites is "what do you need?" Costs, choice of technology and type of service required form a complicated calculus. The equation can only be solved in terms of local need.

This paper has attempted to define needs, processes and the educational community in extremely broad terms. Also it has tried to deal with the question of whether the predominantly local system of education in the United States requires any massive change, requires any increasing degree of federalization. While more nationally produced resources of various kinds will undoubtedly be made available, it is recognized that decisions about educationa' expenditures will continue to be made largely at the local level. The beleaguered economic state of education (unless there is a drastic change in the economy and vast amounts of discretionary money can be made available to education) would seem a strong argument for narrow-band, low-cost technologies, as the "best" expenditure of limited resources.

A FINAL OBSERVATION

Beyond the many tangible benefits that could be gained from the narrow-band applications of satellites described above, there remains a wide-range of less concrete, though perhaps far more profound, educational objectives to be served. Satellites seem destined to become an all-encompassing communications resource, whose union with television, radio, computers, and other techniques promises to radically alter the flow of information both within and between societies. Some speak optimistically about what this will bring, of how satellites someday will deliver the sum-total of human knowledge to everyone on earth, of how the technology will make possible the creation of a new world, "a global village," free of racial strife and unchained from religious and national alleniances. There are others, though, keenly aware of the technology's military heritage and of plans for its commercial development, who see a far less appealing future. In the Foreword to this paper, reference was made to the very real dangers that may lie ahead. They cannot be ignored, and those concerned with the education of this and future generations of Americans would do well to ponder what one informed critic, Theodore R. Conant, (former vice-president of CBS Laboratories and currently Director of Research for the Schroder Technology Group, the J. Henry Schroder Banking Corp.) believes may be in store:

We're going to have a constant bombardment of

> sight and sound. It will be put together more cleverly; it will affect us more subliminally without our knowing it. We'll be able to be better manipulated by it and in that sense it's going to be increasingly difficult to know what the real world is like. It will be sort of like Plato's shadows in the cave. In this world of electronic shadows, it's going to be hard to know what the real thing is. Pseudo-experience of all kind is going to replace real experience. It's going to be an interesting but rather frightening world.[12]

Mr. Conant is quoted at length because his words are a warning about tendencies that already can be seen to exist. More importantly for the purposes of this discussion is the challenge they offer. Educators would be derelict in their responsibility if they approach the subject of satellites without considering its larger social, political and economic setting. While there is much the technology can do to improve the quality, availability and outreach of education, there may be much that the educational community can do to assure that satellites are permitted to develop in such a way that their benefits will be realized by all segments of society, not merely those who by virtue of their unique circumstance possess the ability to pay. The communications satellite, it must be remembered, has been developed with more than eighty billion dollars of public funds. Its future development must be viewed not only in terms of the public resource it is, but in the context of the public resource it can become.

Developing a thorough understanding of the technology -- what it is, how it works, ways it can be used -- will be an

important step in this direction. Just as auto-mechanics, the techniques of printing, and other industrial skills have become part of the public schools' standard curriculum, courses in the uses of communication satellites should now begin to find their way into the classroom. The prevailing view that satellite communications -- like virtually all forms of electronic technology -- lies beyond the reach of average citizens, is largely a myth. Indeed, anyone familiar with the many accomplishments of amateur radio operators in the space communications field is aware of what is possible: For the past fifteen years, "hams" have been building their own satellites to provide worldwide transmission of telephone, telex, data, radio and slow-scan television to low-cost (about $1,000) ground terminals. The satellite equipment used by the amateur radio community, because it is far less expensive and complex than that required to provide such sophisticated commercial telecommunications techniques as color television, can be assembled, as it has been, in home basements, in garages, and in warehouses. It can also be built in classrooms.

While familiarity with the use of the technology alone will not answer all the questions, it will go a long way toward addressing one of the more disturbing social trends taking place in the United States: the trend toward media illiteracy. The surest form of innoculation against the kind of media manipulation feared by such observers as Mr. Conant is for education and educators to take the lead role in both de-mystifying the technology and ensuring that all have equal access to knowledge of its concepts.

CONCLUSIONS/RECOMMENDATIONS

The conclusions and recommendations to follow have been dealt with exhaustively within the text. This section is to provide a recapitulation of what some of the major observations and suggested experiments might be:

1. Narrow-band technology has inherent in it the conservation of rapidly depleting spectrum space and sizeable cost-advantages over broad-band.

2. Broadcast television, unless it can be recorded at used at teacher convenience, can be counter-productive to educational goals and objectives in many situations.

3. Education is viewed as an exchange (a two-way flow) of information, or the communication that takes place within a society.

4. The newer technologies, including satellites, provide a way to expand "outreach" by schools to the communities they serve.

5. One option for educational consideration is to seek non-profit tariffs on existing commercial satellite systems.

6. Telephony can be successfully used for a variety of educational applications and needs, both for content and for administrative purposes.

7. Interconnection of existing non-commercial radio stations

could well serve educators' goals.

8. Slow-scan television, using a minimum of channel space, is a powerful tool for education and one which lends itself admirably to satellite transmission for both formal and non-formal applications.

9. Since a satellite can transmit virtually anything that can be either reduced to an electronic pulse of placed on an electronic carrier, it has considerable potential for data and hard copy uses within and between educational systems. The same would apply to uses of Telex and Facsimile.

10. The relationship of cable systems, radio, and satellites needs further exploration; a wide variety of uses seems possible.

11. Slick production techniques may be totally inappropriate for remote audiences, and "user needs" should drive any satellite system, rather than slickness or production values.

12. The educator should play a major role in de-mystifying the satellite technologies and should further seek to ensure that all have access to the potential these technologies represent.

FOOTNOTES

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6. To obtain a full report of public television's satellite plans, write to Mr. Henry Loomis, the Corporation for Public Broadcasting, 888 Sixteenth Street, N.W., Washington, D.C., 20036.

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