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AUTHOR	Filep, Robert T.
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ABSTRACT

A number of projects have been conducted over the past 10 years to demonstrate how rural education services might be provided via satellite and other methods of telecommunications. Paralleling these activities has been rapid development of telecommunications technology. Increased capacity at reduced cost has been realized in successive interactions of communications satellites, earth stations, computers, and video equipment. This paper provides an overview of the domestic communication markets available for rural education use, a brief history of satellite communication projects that have served rural education needs, and outlines telecommunications developments, both existing and planned, which could be used to an advantage in meeting goals of rural education. Recommendations are provided which address concerns identified by the National Seminar on Rural Education and the Regional Rural Roundtable activities. The importance of conducting an extensive needs assessment to define rural education's telecommunication needs is also stressed, and suggestions are made whereby educational agencies might coordinate with national programs such as those of Farm Home Administration, Department of Housing and Urban Development, Department of Agriculture, etc., relating to telecommunications, in order to amortize investments currently being made to meet rural needs. (Author/AH)

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Telecommunications and the Rural American, Today and Tomorrow

by

Robert T. Filep, Ph.D.

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Suite 206, 1611 South Pacific Coast Highway, Redondo Beach, California 90277, (213) 375-4847
New York New York • Arlington, Virginia

Abstract

A number of projects have been conducted, over the past ten years, to demonstrate how rural education services might be provided via satellite and other methods of telecommunications. Paralleling these activites has been the rapid development of telecommunications technology. Increased capacity at reduced cost has been realized in successive iterations of communications satellites, earth stations, computers, and video equipment.

This paper provides an overview of the domestic communication markets available for rural education use, a brief history of satellite communication projects that have served rural education needs, and outlines telecommunications developments, both existing and planned, which could be used to an advantage in meeting goals of rural education in the mainland U.S.A., as well as in Alaska and the Pacific Basin.

Propitious planning conducted now to assay where rural education requirements can play a part in the rapidly expanding telecommunications market can yield many benefits. Small-scale telecommunications alternatives and appropriate levels of technology must also be considered as rural educators contemplate delivery of services via telecommunications.

A set of recommendations are provided which address concerns identified by The National Seminar on Rural Education and the Regional Rural Roundtable activities. The importance of conducting an extensive needs assessment to define rural education's telecommunication needs is also stressed. Suggestions are made whereby educational agencies might coordinate with national programs of FmHa, HUD, NTIA, FEMA, and the D.O.A. relating to telecommunications, in order to amortize investments currently being made to meet rural needs.

TELECOMMUNICATIONS AND THE RURAL AMERICAN: TODAY AND TOMORROW

I. INTRODUCTION

This document was developed as part of the background material for a "Workshop on Telecommunications in the Service of Rural Education," July 8 to July 9, 1980, sponsored by the National Institute of Education/ED.

It was designed to give workshop participants an overview of the topics, concerns, and citations relating to the current context for the use of telecommunications, by the providers and participants in rural education. The domestic telecommunications resources and capabilities are expanding exponentially. The quality and quantity of rural education can be improved and expanded by planning now to take advantage of the telecommunication surge.

II. THE SETTING

Defining Rural America.

Rural America is extremely diversified. A single description could not encompass such divergent areas as an Oregon coastal fishing village, a mining community in Wyoming, a ranching area in the great Southwest, a Midwest farm community, a pueblo in the Southwest, a settlement of tenant farmers in Mississippi, a town in the Southeast "growing up" into a regional urban center, a lumber mill town in Appalachia, nor a small hamlet in Colorado undergoing a rapid "boom" transition due to coal shale development.

For this discussion, such settlements as the small fishing and trapping villages of Alaska, the U.S.-supervised island communities of the Pacific Basin, and the rural regions of Puerto

Rico are other typical candidates having learners with needs amenable to custom-designed telecommunications systems.

Where the rural area ends and the metropolitan or urban area begins is not always clear. Activities gathering and reporting data on public school systems generally classify these data into Metro (central cities and suburbs) and Non-Metro. Fratoe (1978) initiated the term "rural/non-metro" to describe those in the rural education and labor forces and thus suggest the diversity of areas outside the central cities and suburbs.

In the 1975 Bureau of Census data (USBC, 1975) "rural" refers to any community under 2,500 people. At that time, 26% of our population lived in communities of that size. Relevant to the rural communications concerns, in 1968 36% of the people in these communities listened to radio four or more hours a day, and spent 12% of their discretionary budgets for magazines (NAB, 1970).

The history of telecommunications serving rural education in the United States begins in the early 1930's with the use of radio programs, particularly in Wisconsin, for formal and informal education. As television broadcasting increased during the 1950's and more and more homes had television sets, the stage was set for television to serve education. However, it was not until the late 1960's with the advent of "Sesame Street", which provided daily television programming for over ten million preschool and elementary-age children, that the true potential of telecommunications in education was clearly demonstrated. Today, as we enter the decade of the 80's, the electrifying expansion of satellite telecommunications and cable television, particularly within the past three years, dictates a new appraisal of domestic markets. Emerging fields of digital voice and data communications warrant special study. To capitalize on these telecommunications services and in order to provide better service for participants in rural education, rigorous analysis and planning is required.

Data on television and cable communication indicate that in 1975 approximately 90% of American homes had television receivers (Sterling and Haight, 1978, p. 373) and more than 15% of the households have access to cable television service (Sterling and Haight, 1978, p. 57). Today, more than 94% of American households have telephone service (TITF, 1978). Thus, the people in the rural areas are not out of touch and do have access to telecommunications.

Some additional characteristics of the changing face of rural America must be noted in the light of these earlier statistics. They provide a context for any consideration of telecommunications:

> For decades the population of urban areas grew, while large numbers of people left the farms and small towns. Since 1970, this migration trend has reversed. The annual growth rate of rural areas has averaged 1.3% since 1970, exceeding the rate of growth in urban areas by over 40%. Not only.....are new jobs being created at a faster rate in rural than in urban areas, but the composition of the rural work force itself is changing. Although agriculture is still the dominant influence in many rural economies, overall, employment and manufacturing, trade, and professional services now exceed direct agricultural employment.....This growth in rural population, the accompanying expansion in rural employment, and the increasing diversity of rural economies result from a number of factors -- a strong preference for rural and small town living, the movement of retirees to rural areas, longer-distance job commuting, reduced out movement from farms, and expanded mining, manufacturing, and service activities in rural areas.....Notwithstanding the progress that has been made, a

> disproportionate share of the nation's poor still live in rural areas -- about 40% of the total.....About 1/4 of all rural people live in or near towns of less than 2,500; 3/4 live in or near towns of less than 20,000. (E.O.P., 1978).

Therefore, the term "rural/non metro" seems germane for this particular discussion.

There is no single telecommunications approach that can serve all the education requirements of rural learners, nor is it being suggested that education in the rural areas be served primarily and solely by telecommunications. Integration and complimentary approaches with on-going educational institutions and projects would seem to be, historically, the best approach for success. The conditions for user access to telecommunications must be addressed with particular attention to cost and to regional and national regulations. Barriers to access -- political, institutional, psychological, technological -- all must be considered.

> Within communications, users readily substitute one form of communication for another. For example, a personal communication to a relative may take the form of a visit (voice/visual), letter (text), telegram (text), greeting card (graphic), tape recording (voice), telephone call (voice), etc. A business desiring to promote and sell a product in a community may consider radio (voice) or television (visual) advertising with a phone number (voice), or mail address (text) for orders, mail (text/graphic), mailgrams (text), private delivery services (text/graphic), telephone (voice), etc. The communication form or combination of forms selected will depend somewhat on the user's taste and preference but primarily on the price and expected performance. In educational practice, past history and usability by the student or the instructor, or the system itself may dictate which form or combination of forms will be utilized. (TITF, 1978).

While users will make decisions by selecting among forms of communications as substitutes it should be noted that different forms can also be complementary. The use of one form of communication can generate a need or desire to utilize some other form of communication. A visit (voice/visual) may prompt several prior or subsequent letters (text), telegrams (text), and phone calls (voice). The combination of communications used and how they might be related to the resources available for a particular educaitonal program are discussed at considerable length by Wilbur Schramm in his very excellent text Big Media, Little Media (Schramm, 1976).

III. TELECOMMUNICATIONS IN THE U.S. TODAY

The Basic Forms of Communication

To perceive the opportunities in the current telecommunication services and capabilities provided rural users, it is helpful to examine the various modes of communication used by or available to the individual. A recent report (TITF, 1978) provides interesting insights into selection and use of various communications media. Their suggestions may be reported as follows:

> Communication can be characterized as taking place in one or a combination of six basic forms: voice, data, text, graphic, visual, and signal. Voice generally refers to such things as vocal conversation or message and sound broadcasting. Data refers to digital coded communications between machines. Text is printed alphanumeric messages, such as telegrams or teletypewriter. Graphic refers to pictorial information which, for example, might be produced by a facsimile system. Visual refers to such things as personal visit, television, and video teleconferencing. Paging, alarms and telemetry are examples of signaling.

While user perceptions of communications can be categorized in this way and certainly in other ways, it must be emphasized that user needs for each of these different forms of communications are independent. Of course, all users determine their needs for communication by trade-offs with all of their other needs, available income, or allocated budgets.

In selecting the mixture of communication forms that will best fulfill their needs, users give little regard to the stated form of communications that suppliers provide. The "voice" telephone network is used for all forms of communication, including slow scan video. A "data channel" may be used to deliver text, graphic, signaling, or even voice. Visual and voice are often combined on a "video channel", and text and graphic can be included. Again, price and performance are the key decision variables affecting a customer's choice of communication form from a given service offering.

Users also give little regard to the classification of the supplier they use. Different types of common carriers and private firms offer similar types of service. Price, performance and flexibility are the decisive variables.

Communications Service Markets

As a result of the legislative and regulatory processes and various technological developments, the Federal Communications Commission has segmented the communications market into a number of sub- or service markets. A number of these are considered as separate categories in the recent discussion of the revision of the Communications Act of 1934.

Fourteen major communication service markets exist today: postal and transportation; hybrid data processing; terminal equipment; private radio, broadcast; cable television (CATV); multi-point distribution; telegraph and typewriter exchange service; public switch telephone network services; public mobile radio service; private line service; specialized data transmission service; satellite communications service; and value-added network service.

Current User Data

A number of patterns that have emerged relating to these markets should be recognized in any contemplated use of telecommunications for rural education. Outlined in this section, they are also discussed at length in recent assessments of potential growth for all these markets in the U.S. (*Communication News*, February, 1975; Morgan, 1980).

Potential Impact of Communications Satellites on Users

The author has been asked to focus primarily upon communications satellites and how they might be used in rural education. First, let us examine some of the characteristics of this enormous telecommunications capability.

The primary uses of satellites today, or likely uses in the very near future, include television (TV), for distribution purposes, for direct broadcast, and for teleconferencing. In the business data area, communications satellites are being used for electronic mail, facsimile transmission, computer communications, and telex communications. A rapidly growing use of domestic satellites is for telephone communication, or, as commonly termed, telephony. In the areas of public service, education and health, considerable experience has been gained through the ATS-6 (Applications Technology Satellite) and the joint U.S.-Canadian CTS, (Communications Technology Satellite).

A number of experiments have demonstrated the potential of telecommunications for education and health. The Public Broadcasting Service has established a network via satellite linking together many of the major PBS Stations (public television broadcasting stations) throughout the country. This network is also utilized by the National Public Radio Service to distribute radio programs.

The specific application categories and how they might be used are discussed at greater length in the paper and will be elaborated upon during the formal presentation. They include TV distribution, TV broadcast direct to the home, teleconferencing, use of computers for timesharing, interactive interconnecting data banks, distributive processing, etc. Also to be considered are the use of business facsimile, electronic mail (which can be considered a special form of facsimile), communications via satellite for major and widely distributed office complexes, the potential use for health care to remote areas and for education in rural areas. We will consider satellite networks currently in place and other planned which could be used in rural education. (cf. Communications News, November, 1979; Audiovisual Instruction, September, 1979).

IV. SELECTED EDUCATION COMMUNICATION PROJECTS WORTHY OF NOTE FOR RURAL EDUCATION USERS.

Over the past 10 years, a number of projects have been conducted to provide education services via telecommunications. Particularly communication satellites have been used to reach migratory farm workers, residents of small rural areas, American Indians, and other groups residing in remote rural areas or small islands in the Pacific Basin. (Binder et al, 1975).

This section of the paper highlights approaches and outcomes of the projects. They include the ATS-1 projects in Alaska, the Appalachia region and the Rocky Mountain states; CTS experiments in both Canada and the United States; work conducted primarily in higher education and adult learner programs via Public Broadcasting System networks; Pacific Basin activities which have followed the early ATS-1 activities and are linked to current communication capabilities, and some examples in the education and health areas from Telecommunications Demonstration Programs. (cf Bystrom, 1972, Caldwell, 1976, Cowlan & Foote, 1975, Filep & Johansen, 1978, Hugeboeck, 1975, Law, 1975).

In addition, selected projects have been conducted in other parts of the world to aid communication in developing countries, and which have focused primarily on rural populations. Lessons learned there may be utilized in rural education in the United States. Projects conducted in India, Indonesia, the African nations, and Latin America will be included. The 1979 National Seminar on Rural Education (discussed in the next section) suggested such an examination in its Recommendations.

Health care experiments have been conducted during the same period. In some instances, they have demonstrated more direct value for users than some of the educational projects. Particular projects will be selected to show how user needs are assessed; to illustrate low-cost utilization of telecommunications to deal with particular user needs, and to demonstrate approaches for improving in-service training of health professionals from the entry to the senior levels. (cf. Feiner, 1974, Foote, Parker & Hudson, 1976, Kreimer, 1974, O'Connell, 1978). An analysis of the two-way telecommunication projects designed for rural requirements in health and education on both the domestic and international scenes was provided in a recent AID sponsored document (PCI, 1977).

IV. SELECTION EDUCATION COMMUNICATION PROJECTS WITH RELEVANCE TO RURAL EDUCATION

Brief History of Satellite Communication Systems in Education

One of the most ambitious projects undertaken to extend, diversify, and intensify education as well as ~~to~~ extend health services began with the successful orbiting in May 1974 of a synchronous communication satellite. Soon after it was launched and attained orbit, the National Aeronautics and Space Administration (NASA) redesignated the Applications Technology Satellite-F (ATS-F), the ATS-6 to indicate that it was a live, functioning satellite.

Prior to the ATS-6 experiments, there had been limited application of satellite technology to education or other programming either in the United States or elsewhere (Filep, 1978). Initially, ATS-1 and ATS-3 satellites contributed two-way audio capacities to a small range of experiments in Alaska. These satellites were insignificant, however, compared with the ATS-6, which has audio and video capabilities and a potential for interactive traffic. ATS-6 was also unique because its high power made possible the use of inexpensive ground stations.

The Satellite Technology Demonstration (STD) was one component of NASA's overall Health/Education Telecommunications experiment on the ATS-6. The main purpose of the STD was to demonstrate the feasibility of a satellite-based system for media distribution to isolated rural populations and to test and evaluate user acceptance as well as cost of diverse delivery modes and materials (Bransford and Razzaro, 1975).

The three areas covered by the experiment -- the Rocky Mountain States, Appalachia, and Alaska -- have certain common characteristics: geographic barriers that prevent even public television from reaching certain locations, and a large proportion of the population comprising underprivileged ethnic groups scattered in rural areas and having limited contact with the outside world (National Institute of Education, 1975).

In the Rocky Mountain states, the prime educational aim of the STD experiment was to provide junior high school students with career education, a new concept even for teachers. More than sixteen programs specifically directed to teachers constituted a major component of the design. Eleven more programs were produced for the general adult audience.

Most previous experiments in instructional television had been limited to one-way communication. The ATS-6 STD program used two-way communication for interaction among students, teachers, regional coordinators, and consultants. Similarly, the most important aspect of the adult programming was the opportunity for interaction between moderators and guests in STD's Denver Studio and viewers in the participating communities.

Another important aspect of the STD demonstration was the satellite's potential for feedback from the user community, which did not require real-time interaction. The Material Distribution service enabled teachers to order a wide variety of instructional programming from a videotape collection in Denver and to receive offerings quickly via satellite.

The main objective of the Appalachian Educational Satellite Project was to meet teacher's needs for in-service training, especially in the subjects of reading and career education, since this was the most pressing problem in the area (National Institute of Education, 1975). This project has successfully produced courses in one location for a region covering many states that remained sensitive to grassroot preferences of the smaller communities within the larger area.

An innovation of the courses was role-playing, which proved most effective. The satellite enabled the teacher-students to ask questions at their receiving sites during live broadcasts. Role-playing with such interaction thus enhanced the educational process.\ Role-playing was integrated into the audio review and the taped television programs; even the unit tests focused on these studies to encourage role-playing. Many teachers who took the courses stated that "the courses were not impersonal experiences even though there was no instructor on site." (Bramble and Ausness, 1976)

Another major component of the Appalachian Educational Satellite Project was a computer-based information system using a combination of computer-based and manual systems for storing, retrieving, and delivering to teachers in their communities information and instructional materials in reading and career education (Bowling and Maynard, 1976).

Since Alaska is the home of many different ethnic groups, most of whom undertand only their own language, programming in Alaska has emphasized the development of courses in oral English. With two-way audio capacity, both teachers and students now have a "model" with whom to converse in English.

Another achievement of the satellite project in Alaska was a weekly half-hour broadcast called "Alaska Native Magazine." This program dealt with such local problems as land claims, the oil pipeline, and native culture and arts. This program is broadcast in English and in several native languages to promote cultural pride and intercultural exchange among Alaska's many communities (National Institute of Education, 1975).

Research Findings

Many studies have been carried out on the effectiveness of interactive broadcast television. This type of media research generally is characterized as "evaluative comparisons." In a typical experiment, learning from television is compared with classroom instruction. Schramm (1967) has provided some insight gained from an exhaustive review of various studies on the subject. "There is no magic about television teaching. Television is a pipe. It is as good as what goes through it. If the content is dull, the teaching is dull. If the basic rules of instruction are ignored, the result can be as bad as the worst classroom teaching. Indeed, the emerging view is to regard television as one element in a learning system, and to pay increasing attention to the learning experiences provided at the receiving end."

Roberts and Schramm (1971) and Twyford (1969) reported that television effectiveness in learning seems to be related more to quality teaching than to anything else. Television instruction is successful when the program content is well-organized, meets high pedagogical standards, and is presented in a learning context.

A review of the literature on the effectiveness of television in general and interactive television in particular is characterized by a preponderance of "no significant differences." Obviously, television used stimulatingly and resourcefully is a dramatically successful medium.

A fundamental characteristic of television, as Millerson (1961) describes, is its visual and sound images that reveal information as directly and as close to reality as possible or that offer selective aspects of reality that modify meaning or create images that change the reality by inventing new symbols to heighten the learner's imagination through association. Therefore, sound and image represent reality to establish context, to interpret, to model, to imitate, to recapitulate, to couple, and to interplay.

Chu and Schramm's Learning from Television: What the Research Says and Dublin and Hedley's Medium May be Related to the Message: College Instruction by TV are comprehensive reviews on instructional television (ITV). Chu and Schramm surveyed 421 comparisons of ITV with traditional instruction, and Dublin and Hedley reviewed in more detail the effectiveness of ITV at the higher education level. The latter researchers reviewed 191 comparisons, of which 102 found ITV to be marginally more effective. Both of the studies focused on achievement and attitudes toward television compared with traditional instruction, with the expected "no significant" findings in the variables tested. In the section entitled "Research on Teaching Strategies" in What the Research Says, Schramm makes important references to design elements that should be carefully heeded in any project involving course programming and formative evaluation.

Numerous studies (cf. Kirsh, 1952, Carpenter and Greenhill, 1958) suggest that a significant proportion of instructional time should be devoted to student participation. However, the relatively high-cost of conventional television precludes its extensive use to meet individual needs in rural areas. Other forms of telecommunications, such as voice or text, as well as periodic personal visits should be used in the total teaching system. With the availability of an interactive component of television carefully designed to provide structured, active student participation and immediate confirmation of the knowledge gained, interactive systems will be more functional and economically feasible. In addition, as the previously referenced research indicates, positive student attitudes toward interactive systems will further enhance learning.

Dubin and Hedley's analysis of 26 comparisons of ITV, which included an audio return capability that allowed students to ask questions during a live ITV broadcast, also showed a highly significant advantage for traditional instruction. In neither of the studies was there any indication that the audio capacity was used to elicit active student response and immediate confirmation of results to increase learning. In these studies, students used the talk-back capability with the studio in a piecemeal and disorganized fashion, which also could have been a barrier to learning. In short, to be effective the talk-back capability needs some formating or structuring.

A recent "true" experiment that incorporated experimental psychology findings into the area of instructional design and human learning was Michigan State University's two-way communication project in Rockford, Illinois, to train firefighters.

The project was based on the general hypothesis that interactive telecommunication training would result in more learning, more ITV system satisfaciton, and more positive effective responses to training concepts than one-way television training (Baldwin, Greenberg, Block, and Stoyanoff, 1978).

Four discrete treatments provided thorough test of the two-way system: two-way group condition, two-way individual condition, one-way non-interactive response condition, and one-way response condition. The two-way individual and two-way group conditions provided a comparative value of an independent variable, namely personal interaction and individualized feedback as opposed to group interaction. The one-way noninteractive condition required the same response action, which was circling an item on a form rather than pushing a button. In the one-way covert response treatment, the participant could choose not to make the covert responses.

Though the respondents on the cognitive tests showed no pre-experiment differences, those in the two-way condition tests showed significantly more learning than those in other test modes. Performance of firefighters in the one-way covert response condition were slightly better than that of participants in the one-way paper-and-pencil condition. Overall, tests indicated increased learning, greater interest, and more satisfaction in learning in the interactive telecommunication mode than in the one-way television mode.

The Rockford findings are significant generally because of the sample size and also because the participants were chosen and assigned to the treatments at random. Another experiment in the series to determine the effectiveness of two-way television was conducted by New York University in Reading, Pennsylvania. Designed to evaluate the use of two-way television to provide services to senior citizens, the project produced little significant research data but clearly succeeded in its humanistic objective: to promote interaction and awareness of the social services among the elderly. It was also successful in effecting positive attitudes among the experimental groups: as much as 80 percent of the viewers identified the interactive television system as the major improvement in their lives (Moss 1978).

The consensus at National Aeronautics and Space Administration (NASA) Conference in 1976 was that in-service training can be effectively delivered using telecommunications technology. The following conclusions were made (Blackhurst, 1978):

1. Information is the raw material of instruction and learning.
2. The user should dictate the form, time, and place of needed information.
3. It is cheaper to move information to the user than to move the user to the information.
4. It is cheaper to move information electronically than by any other means.
5. Most information can be stored, updated, and retrieved electronically.
6. All electronically stored information can be electronically distributed to a large number of remote users.
7. Electronically stored and transmitted information can be given to a user in any electronically related form, e.g., cathode ray tube image, full audiovisual, computer printout, facsimile.

A recent project, the Indiana Higher Education Telecommunication Project, used closed-circuit interactive television for in-service training over an 18 month period for a series of 10 hour-long presentations (Carpenter, 1976). User attitudes toward the ineractive systems were generally positive. Ninety percent of the participants said the programs were of good quality. Further, the interactive portion of each program, in which viewers could respond to the presenter, was rated by the participants as a crucial part of the program.

Viewers rated favorably the spontaneity of the interactive systems, and the clarifications and explanations of the presenter. In summary, 83 percent of the respondents either agreed or strongly agreed that the interactive system was useful and did not feel inhibited by responding in a live, state-wide program that lasted 20 to 45 minutes.

Another example of successful interactive learning systems is the Project Interchange conducted by the Archdiosese of San Francisco. In this project, programming was broadcast, via IFTS, from a studio in Menlo Park, California, to NASA's Ames Research Facility, then beamed to the CTS satellite and transmitted to terminals in San Francisco, Los Angeles, and Chico, where individual schools are located (Green & Lazarus, 1977). This system enabled the teachers to exchange information, ask and answer questions, and transmit drawings and graphics via telephone lines back to the studio in Menlo Park, where they were retransmitted through the system so that all the individuals could participate (Blackhurst, 1978).

In a broader context the review of research on interactive satellite systems supports the great need for research on the importance of instructional design elements such as advance organizers, active student participation, reinforcement schedules, feedback, additional sets, etc. into course design for optimum efficiency and effective utilization with interactive systems in any area of teaching and training.

V. POTENTIAL TELECOMMUNICATIONS USE IN RESPONSE TO NATIONAL FORUMS AND PROGRAMS.

A number of programs have addressed the rural problems of distance and size, as they relate to small communities and rural development. Out of these have evolved a number of policy positions and particular programs being funded to meet needs other than in education. These programs may suggest ways in which those interested in enhancing rural education through telecommunications may explore joint or simbiotic activities that will parlay the concern and investment that has already been made by other agencies. (Fratoe, 1978, Darby, 1974, Roefield, 1978).

In the area of education, two recent activities funded by the Department of Education (DOE) have included the National Seminar on Rural Education and the Regional Rural Roundtables. These activities have given particular attention to the needs of rural learners and telecommunication's potential role. Also of interest are the recommendations and potential for telecommunications as outlined in the recent White House report <u>Small Community and Rural Development Policy</u>. (E.D., 1980, Jacobsmeyer, 1980.)

In addition, programs initiated in the transportation and communication areas suggest that they may provide supportive roles for rural education. Also, some major rural health initiatives have led to establishment of health clinics and other facilities in concert with public education facilities in the rural areas.

Thus, telecommunications may advance both health and education objectives if these facilities are used as community centers with telecommunications capabilities. (Shamaskin, 1977, Roberts et al., 1977.)

The Farmers Home Administration (FmHA) has been a principal key provider of domestic assistance and in 1978 started the National Rural Communities Facilities Assessment Study (NRCFAS). The project staff will assess, assay, and then make recommendations regarding service facilities in rural communities such as Health and Education as well as outline telecommunications requirements (Chinitz, 1979).

VI. PLANNED AND FUTURE TELECOMMUNICATIONS APPLICATIONS RELATED TO RURAL EDUCATION

A particular characteristic of telecommunications technology is its rapid development, whereby increased capability at reduced cost has been realized in successive iterations of communication satellites, computers, telephone equipment, and so forth. Per unit message costs have decreased with improving technology. A number of telecommunications developments which could prove very useful to rural education objectives are in the planning stage, and currently being tested on a small scale.

Among these developments are laser technology, the launching of the space shuttle and the attendant ability to put much larger communication spacecraft in orbit, such as the geostationary platform. Larger communication satellites could provide many small antennae for selected and small populations throughout the country. In addition, the burgeoning interest in small, direct home broadcast antennae of 3-meter size or less augur well for rural needs. These antennae, which will be extremely low in cost and easily installed, could have wide distribution in remote rural areas to receive many forms of telecommunications. (Carne, 1979, Kaplan, 1979, Mantino et al., 1979).

Background:

The characteristics of a demonstration geostationary platform are now precisely defined. Communications equipment and scientific hardware can be carried on the test vehicle. Cost and engineering analyses indicate that the platform is cost-competitive. Alternative data-supported configurations that allow for the selection of various mission capabilities clearly indicate the ability to launch a multitransponder-equipped platform on a single shuttle flight (cf. Bowman et al., February 1980 and March 1980; Aviation Week and Space Technology, March 1980). The platform can be considered a serious candidate whenever decision-makers discuss the types of large communication satellites that might be available in the late 1980's to meet the increased voice, video, and data requirements projected for that period and for the accelerating demands of the 1990's (cf. USITT, August 1979).

Other concepts have been discussed, such as satellite clusters, a "string-of-pearls" approach, and increased launch capabilities for putting larger single satellites in orbit. As the platform capacity, cost, and crowding ratios are compared with other proposed space vehicles, advances in communication satellite technology come to bear, such as outer cylindrical solar panels for spin-stabilized satellites and improved earth stations with reduced radiation in unproductive directions.

The current World Administrative Radio Conference (WARC-79) in Geneva could provide additional rationale for space platforms, if indeed there is a worldwide requirement specific frequency bands would be reserved within regions for individual nations. Such an action, or related reservation of orbit-arc options, would highlight the potential value of geostationary communication platforms as a means for each nation to have its own communication module on a platform, and thus obviate separate satellites for each.

Connectivity Within and Without

The central computer systems and distributed processors in the space platform could control the mechanical devices and the handling, storage, and processing of a variety of communications, command, and telemetry signals. Their role would be primarily one of processing rather than of relaying. Intra-connectivity within the platform to handle a range of frequency requirements would eliminate the current need for ground-to-satellite-to-ground interconnections, would speed up transmission, and would minimize potential interference.

If a number of platforms were put into operation to provide world-wide coverage, the limitation of current satellites, which provide transmission only between points within a single satellite coverage area, would be overcome. Inter-platform links could provide coverage for different zones and would speed up transmission, with improved service, quality, and economy.

A 1973 Rockwell report outlined how four C-band platforms might provide coverage for the earth. Of particular interest to the Pacific was the Region I conceptualization that stated:

> In order to minimize the required number of platforms, the idealized location of the Region I platform was selected as 172 degrees east longitude, the geographical coverage within communication line of signt for this platform location. Trans-Pacific Comsat and Pacific Ocean navigation and traffic control

functions are readily accommodated from the Region I platform.

It is practical to provide Comsat service to some areas in the western sector of the region, namely, Japan, Southeast Asia, Philippines, Indonesia, Australia, and New Zealand. However, the domestic communication requirements for the East Asian-Australian sector of the world are not uniquely identified in the traffic model. A total of five 12-channel satellites was defined for serving Comsat functions for all of Asia and Australia. It was assumed that two of the satellites were for countries at the eastern extremity of Asia and Australia. Thus, the Comsat requirements for each Region I platform are 12 channels.

Trans-Pacific Comsat requirements were delineated in the traffic model as two 12-channel satellites. Each data relay platform must provide 12 channels for this function.

Trans-Pacific navigation and traffic control was also stipulated in the traffic model. Although only one satellite was specified for this region, it was not considered practical to subdivide the required capability between two platforms. (Rockwell International, 1973, p. 527).

A recent INTELSAT contract is directed toward developing a TWT that would provide the technical capability for inter-satellite links. This TWT activity is relevant to the platform endeavor. (Communications News, July, 1979)

SECOND-ORDER ARGUMENTS

Other marketable features and conditions are related to the anticedent features such as interaction, declining telecommunications costs, etc., but stand alone as suitable for advancement domestically in the Pacific Region, and elsewhere.

Multiplicity of Service Approaches

The history of communications technology has demonstrated that users are served in many different ways by variations of related technology. The geostationary platform is no exception. In the 1980's, there may be integrated communications services via space vehicles that combine multipurpose geostationary platforms and customized communications satellites. The platform can support communications, as well as other payloads such as weather, storm tracking, and recording the interaction of solar activity, atmosphere, magnetsophere, and ionosphere to provide improved prediction and warning. These multiple capabilities, combined with improved mobile communications for ship and shore, are being examined as missions for a demonstration platform (Bowman, 1979; Carey, 1979).

Personal Communications

The growth of the transistor radio and the hand-held calculator serves as a precedent for wide-scale, individual use of personal wrist radio-telephones. Personal communications in the form of wrist radio-telephones linked by geostationary platforms could serve many personal needs. The potential low cost and the capacity for many users in such a system is intriguing and constitutes a compelling reason for some to advance the entire platform concept. Designers have recognized the many problems with this approach, but it should not be discounted as a possible mission, even in primarily for international as opposed to domestic use.

Ideal for Developing Nations

A geostationary platform might be very attractive to a country such as the People's Republic of China which has no sizeable capital investment in terrestial telecommunications but would like to quickly establish video, voice, and data communications. Low-cost earth terminals could be combined with a platform, providing multiple frequencies for a full-service capability, along with earth resources, weather, and narrow-band services at the outset.

Selection of Missions That Have High Telecommunications and Transportation Payoffs

The social and political climate in which the platform must be "sold" will center on energy: energy conservation, high energy costs, and conversion to alternate energy sources. Since a platform can be used in place of medium- and long-distance hauling of mail, for example, its use will be especially attractive because it saves paper, cuts energy consumption, and reduces pollution. The sizeable growth of teleconferencing 18/30 GHz studies (NASA, LECRC, 1979) is very encouraging for a geostationary platform program. The sizeable wide-band requirements are ideal for the multi-transponder platform and allow any brief for the platform to underscore energy savings (fuel savings in air and ground transportation), time savings, and reduced pollution.

ISSUES FOR THE PACIFIC REGION

Where the Pacific region is concerned, recent discussions at the Pacific Telecommunications Conference in January 1980, pointed up a number of major issues that must be considered.

- For a platform to be a viable vehicle in the Pacific (1) user demand must be demonstrated, (2) a fiscal structure must be established to allow both heavy trunking requirements and service to small, remote users, and (3) regulatory problems must be solved that involve the many potential national participants, e.g., the United States, China, Japan, Peru, Australia.

- Currently, the ATS-1 and the ATS-3 satellites provide service for many smaller users, whereas INTELSAT was designated mainly for heavy trunking. The question arises as to who will provide service to the small users once the 1 and 3 are turned off.

- Consideration should be given, however, to having INTELSAT serve as the managemene entity for the Pacific-Asia Region, since it has excellent experience in orchestrating legal and use requirements between nations.

- A financial structure might be established whereby a platform could have a C, KU, and KA capability and could provide heavy trunking service while simultaneously providing S-band or antennae and power to serve small island users, ships, etc. The forecasting and early-warning platform features are very attractive.

- A feeder concept might be established whereby small users could tie into major trunk lines for voice, video, and data service via switching on the platform. This might be comparable to city streets feeding into freeways and vice-versa.

- A potential price structure could provide differential rates for large and small users, comparable with long-line domestic service, ~~thereby~~ underwriting the actual cost of local service. Eventually the small users might provide a large enough aggregate market to pay their own way. The larger users might manage and operate the platform. (cf. Smith, 1978)

- Currently, many small islands and countries can neither support the purchase of an INTELSAT A or B earth station nor allocate annual funds for an M and O.

- The Marisat model also may be worthy examining for the Pacific, whereby one large user, such as the U.S. Navy, underwrites approximately 75 percent of the cost and other ships underwrite a smaller percentage.

- The Pacific may have unique requirements, but in the final analysis it may not be plagued with as congested an orbital arc as other regions of the world. Whatever "solution" the platform may provide, it also must include ingredients of affordable communications to small users as well as ground terminals to fit such a system.

Other Factors Favoring Rural Education

In addition, forecasts of domestic voice, video and data traffic through the year 2000, show that satellite carriers will capture an increasing percentage of each market and provide lower per-unit cost (NASA, LERC, 1979). Video-conference use will exceed network growth in video service areas. The projected growth augurs well for satellite-related rural education projects, since satellite communication is particularly applicable to rural education.

Paralleling growth in satellite use is the burgeoning market for electronic message services. In eight electronic message service areas -- telex, mailgram, facsimile, telegram, faxgram, package switching networks, special services and money order transmission -- revenues are expected to have tripled between 1978 to 1988. The current market of 550 million is expected to be 1.4 billion by 1988 (Communication News, November, 1979). In a forecast of public service satellite communication activities, including transfer of student records, data transfer of universities and libraries, information service and adult educational broadcasting to rural areas, a modest gain for educational use is predicted through the year 2000, based on cost per unit/use. By far the fastest growth in satellite communications usage is seen in disaster management (Martino, et. al., 1979).

A number of factors may converge to reduce the per unit cost of telecommunication via satellite or terrestrial means for rural users. The telecommunications technology variables include: expansion of telecommunication services, provision of more wideband service and thus more capacity for educational teleconferences and television, and the availability of smaller reception equipment (such as satellite-earth terminals), particularly advantageous in rural use.

Recent FCC filing for domestic satellite slots has stressed increased communication capacity in satellites (Satellite News, June 25, 1980, April 30, 1980). These more capacious satellites will provide service on more frequencies (C, Ku, and Ka) and provide two-way use in rural areas, with at least 40 direct-to-user pencil beams with 4 channels of service (Hughes, 1979, Bond, 1979, Morgan, 1979). To provide telecommunications services to sparsely populated areas, telecommunications companies must see a potential user market that can be aggregated to pay for the company's investment. With less expensive equipment and lower per-unit cost, the predictable participation of many rural schools promises higher volume of traffic and a growing market. Increased options and lower per unit transmission in addition to satellite telecommunications with lower terrestrial video circuit costs (coaxial cable, microwave, fiber optics) will all realize a significant drop by the year 2000, with fiber optics cable demonstrating the largest decrement (USITT, 1979).

With population shifts to rural areas, telecommunications traffic patterns also change. As one would expect, current patterns show that the northeastern U.S. has the heaviest usage per square mile. Only 3 percent of the country generates more traffic. By the year 2000, however, the southeast and southwest will have experienced major population growth and a high level of telecommunications traffic will be originating from almost a third of the area of the U.S. Rural areas thus will be more metropolitan in their use of telecommunications than currently. Traffic density maps of the U.S. for 1980, 1990 and 2000 portray this shift of population and telecommunications use quite dramatically.

Predictions of common carrier microwave transmission involving earth station locations in Phoenix, for instance, indicate great expansion over the next 20 years, with major increments in telecommunication service (Western Union, T.C. 1979). Rural education personnel and facilities can participate in this growth and can take advantage of both the direction and magnitude of telecommunications expansion in the U.S.

In a discussion of "Big Comsats for Big Jobs at Low User Cost," Ivan Pekey (1979) suggested that increased capacity provided in the 1990's by large satellites along could link all 65,000 schools, 16,000 school districts, or 4,000 universities and 250,000 other learning sites to provide in a remarkable pattern at equally remarkable cost: fixed and transportable service, color TV, and two-way voice, with 24-hour-per-day use with terminals costing less than $300 per unit.

VII. ISSUES AND RECOMMENDATIONS

Obviously, a number of issues relating to policy and practice must be identified at the outset if telecommunications are to be effective and financially promising enhancements of rural education.

Among these is the precise definition of user requirements. The diverse nature of the population, the inability to aggregate large markets, and the dispersion of learners and their subject interests in any one particular area inhibit mass approaches. Developing appropriate programming poses a major challenge to both creative and entrepreneurial resourcefulness. Consequently, considerable attention must be given to inexpensive yet accurate ways to identify user requirements prior to planning for or installing telecommunications capability. (Mertins & Bramble, 1976, 1976a).

The establishment of large-scale telecommunications networks for rural education may indeed be possible, and some attention must be given to this approach as a cost-effective means for serving many regions of the country. (Perrine, 1975, P.C.I. 1977, Rush, 1978). The growing communications satellite capacities and contemplated expansion can provide a cost effective skeleton for a network. But satellite technology may be only one component in a total system of utilization of this remarkable resource.

In addition, smaller-scale telecommunications alternatives and appropriate levels of technology must be considered in concert as rural educators contemplate telecommunications delivery of their services. The issues pertaining to integrated education packages, which might include telecommunications at one extreme and printed material at the other, should be addressed at the outset. (cf Schramm, 1977, Glatier, 1980).

Workshop participants should consider the following recommendations:

1. Planning should be started immediately on a 5 - and a 10 - year plan identifying specific steps, resources required, participating agencies, and other factors essential to developing rural education agencies, applications parallel and symbiotic with expansion of the domestic telecommunications market.

2. A detailed and extensive needs assessment of rural schools and learning facilities should be conducted to ascertain the present level of telecommunications service, the educational interests and requirements of users of all ages from preschool to senior citizen, and the potential ability of rural areas to provide some level of resource to implement a basic telecommunications network. This estimate should be integrated

with NTIA, FmHa, and other current assessments of needs of rural area residents.

3. Attention should be given to coordinating education and other human services to distribute costs of telecommunications utilization across a larger population of users. For instance, contemplated rehabilitation of 300 primary health clinics in rural areas and the planned pilot program to use public shcools as sites for primary health care calls for realistic and rigorous study of the cost and use feasibility of telecommunications receiving and transmitting capabilities at each center and school.

4. The National Seminar on Rural Education and the Regional Rural Roundtable recommendations, which dealt with Enhancing Local Initiative (11, 12, 13), Special Delivery of Services to Rural Education (15), Technology (17), ESA's (18), and Data Collection and Research (19) all could be supported and carried out with a telecommunications network encompassing low-cost earth stations, data terminals and printers, and television sets in key rural school centers. These sites could receive video, voice, and data and transmit voice and data.

5. Discussions should be held with NTIA, FCC, and other agencies to find out how rural education users might share in the contemplated expansion of broad-band capacities. This might be done through special rates and use of "third-shift" capacities for transmitting bulk data, among other approaches.

6. The Department of Agriculture (REA) should be consulted about plans for helping rural telephone companies to provide television and other services, including rural education as an important objective.

7. The possibility of NTIA Broadcast Facilities and Technology Demonstration Grant programs providing for matching support for rural school telecommunications needs should be investigated.

8. Rural housing projects, e.g., FmHa, HUD, or other federal or state agency funding should be strongly advised to include provision for wiring, weight-loading, etc. at the outset to facilitate installation of telecommunications receivers and related equipment such as printers. Such provision would greatly reduce costs of telecommunications service for rural residents.

9. Discussions should be conducted with the FEMA to determine if their proposed domestic emergency communications system could support and carry educational programs during non-emergency or non-disaster periods. Such a liaison with FEMA could provide an excellent basic delivery system for rural education.

At first glance, the overall market for rural telecommunications does not appear to be as large, as concentrated, or as attractive to those who would invest in telecommunications for rural education use, as the first optimistic readings might have suggested. Some consideration, consequently, must be given to developing marketing incentives to encourage initial investment and development with the realization that, in the final analysis, there could be large aggregate markets and payoffs for ground-floor investors, whether these be public or private sector investors.

As with the opening of wagon trails, roads, railroads, telegraph lines, and, more recently, air routes, the need to open "telecommunications highways" to rural areas provides a great challenge and many opportunities for rural education in the United States.

R.T. Filep
7/3/80

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