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A GUIDE TO THE LITERATURE ON APPLICATION OF COMMUNICATIONS SATELLITES TO EDUCATIONAL DEVELOPMENT

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Prepared For

The ERIC Clearinghouse On Educational Media And Technology

Stanford University

WASHINGTON UNIVERSITY / ST. LOUIS / MISSOURI 63130

PROGRAM ON APPLICATION OF COMMUNICATIONS SATELLITES
TO EDUCATIONAL DEVELOPMENT

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PREFACE

This guide represents a first effort to gather together literature and other useful information in the field of application of communications satellites to educational development. We welcome additions and corrections of either omission or commission.

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I. INTRODUCTION

Communications satellites are one of the communication technologies which are capable of transmitting and distributing electronic information (radio, television, digital computer data) for use in education. Because of the ability of satellites to deliver signals over wide areas with potentially attractive costs in the 1970's, considerable interest has been shown in using satellite technology to enhance educational programs, both in the United States and in other countries. Major planning efforts for such utilization are underway within large countries; in particular India and Brazil. UNESCO, in conjunction with the International Telecommunications Union (ITU), is studying the possible use of satellites for regional development in both South America and Africa. The French Space Agency has undertaken extensive planning studies for educational satellite utilization for French-speaking Africa. Experimental transmission of radio and television signals via satellite have been carried out within the United States and a series of experiments are planned for the early 1970's involving the experimental use of satellites for education in Alaska and the Rocky Mountain States, and in India.

Communications satellites represent a relatively new technology which progressed from ideas to reality after the launching of Sputnik in 1957. Their primary use to date has been in connection with national defense and in the development of intercontinental, commercial long-distance telecommunications (the "Intelsat" and "Intersputnik" systems). It is only within the last five years that serious attention has been given to the use of satellites for educational purposes, with the initial emphasis on countries other than the United States. A series of studies and experiments are now being undertaken to explore utilization in the United States as well. The reader should keep in mind that in considering the educational uses of satellites, we are surveying a field which is still very much in the planning stages and entering a period of experimentation in the 1970's.

The person wishing to obtain a broad overview of the literature relevant to the subject of application of communications satellites to educational development is confronted with a wide range of material cutting across conventional lines. The subject of satellite technology is perhaps the best defined and most readily available. However, in examining the use of satellites in education, there is a growing body of literature dealing with legal, economic, organizational, social and political factors, as well as the entire topic of the use of media and technology in education to consider. There is also information available on systems and experiments planned for the U.S. and other countries. The role of satellites in the total communications "mix" of a given nation or group of nations may be different, depending upon the amount and nature of the ground communications equipment (microwave, cable, TV broadcast stations, etc.) currently available. Thus, detailed planning for educational satellite utilization requires careful examination of local conditions.

In this literature guide, we provide an introduction to three subjects, satellite technology (Chapter II), non-technological aspects, including economic, organizational, social, political and legal factors (Chapter III) and educational and developmental uses of satellites, including experiments and systems planned or proposed (Chapter IV). Also included is a basic reference shelf, which will provide the reader with a broad overview and a good starting point for a more detailed literature investigation, and a guide to organizations with interest in educational satellite utilization. Finally, we have included a bibliography.

II. SATELLITE TECHNOLOGY

There is an extensive body of literature which deals with satellite technology, the large bulk of which is written for the technical specialist. In this guide, we will emphasize those works which are most readily understandable to the non-technical reader, i.e. someone interested primarily in educational aspects but who wishes to learn something about what satellites are and what they can do. It should be mentioned that as with most technological developments, rapid changes are taking place.

In 1945, the radio engineer and science fiction writer, Arthur C. Clarke, first proposed using communications satellites in an article entitled "Extra-Terrestrial Relays" which appeared in the magazine "Wireless World". The history of the development of this technology is set forth in the book "The Beginnings of Satellite Communications" by John R. Pierce*, another pioneer who has made notable contributions to the field.

In 1965, the synchronous satellite, "Early Bird", developed by the Hughes Aircraft Company was launched by NASA. Such a satellite, when placed in circular orbit approximately 23,000 miles over the equator and when moving with the rotational speed of the earth in the same direction, will stay in one fixed spot relative to the ground. Three of these satellites in the proper position could beam signals which could cover almost the entire surface of the earth. However, the large number of political sub-units occupying the earth's surface work against this kind of resource sharing. On the other hand, there are only a limited number of orbital "slots", that is, positions on the great circle around the earth which defines the possible positions of a synchronous satellite, which are available for these satellites. If they are spaced too close to each other, their signals will interfere. Hence the technology itself, if it is to be properly utilized requires some form of cooperation, be it among nations or among states within nations.

Communications satellites contain transponders, devices which receive signals from ground transmitters, process them and send them to ground receivers (See Figure 1). The frequency at which they are sent to the satellite is called the "uplink" frequency and the frequency at which

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*Many of the materials referred to in the text are cited in the Reference Section, (Chapter V) and/or Bibliography.

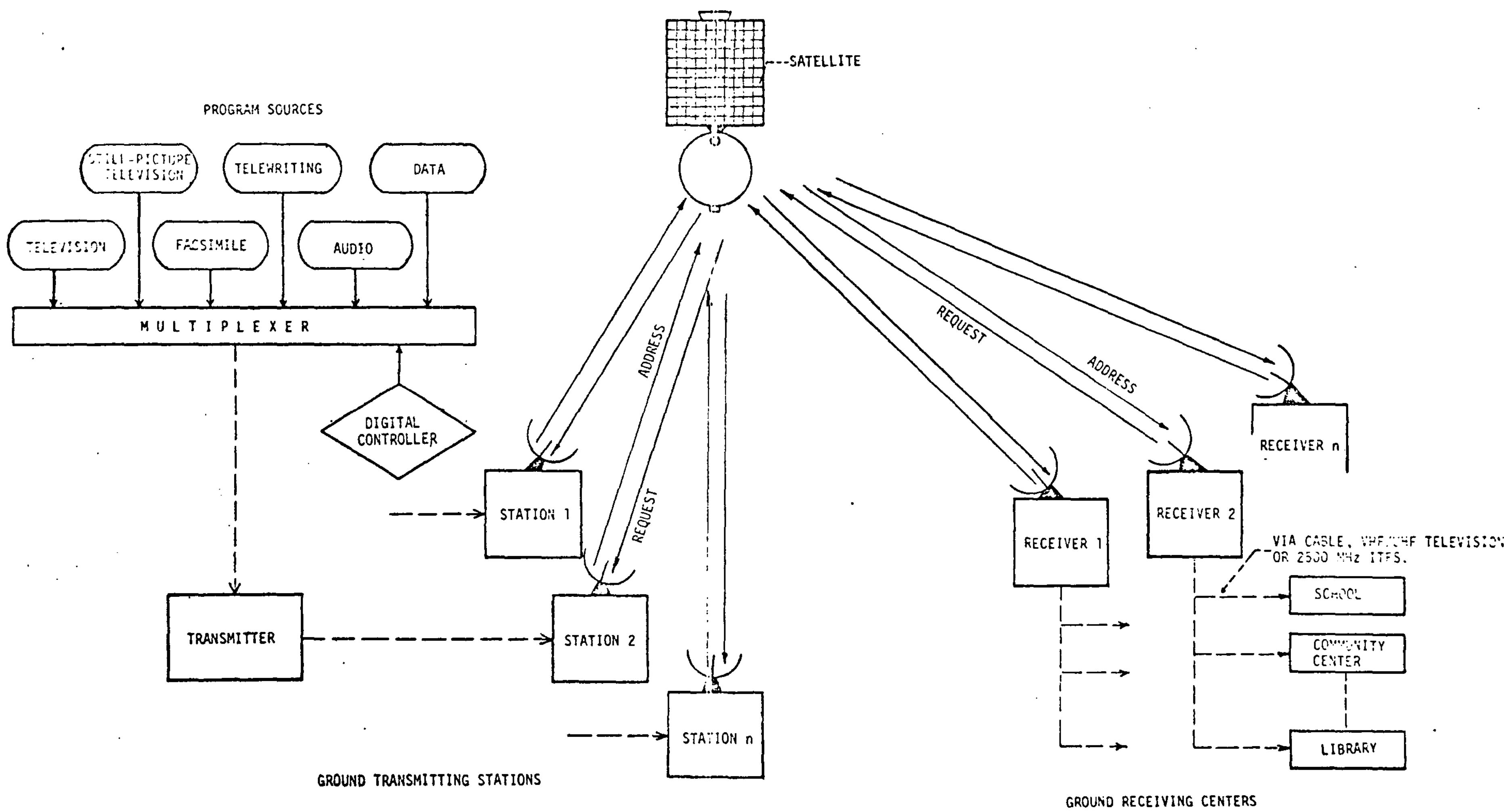

Figure 1. EDUCATIONAL SATELLITE SERVICES

they are received on the ground is called the "downlink" frequency. These frequencies, along with the strength of the signals sent, the bandwidth occupied by the signals, the method of transmission, and the angle of arrival on the earth's surface are all important factors in satellite system design. In general, larger, high-powered satellites can send out stronger signals which can be received by smaller, less costly ground installations. The signals must not interfere with UHF signals being broadcast or microwaves being relayed on the ground. The bandwidth used must be sufficient to carry the desired message with a minimum of power transmitted from space.

In July of 1971, a World Administrative Radio Conference was held in Geneva to allocate frequencies for satellite transmissions. This Conference is held periodically by the International Telecommunications Union, an organization of 139 nations which seeks to ensure the beneficial use of the limited frequency spectrum for all nations. At that Conference, in which certain frequencies were allocated, two important definitions of satellite services emerged, namely, the "fixed satellite service" and the "broadcasting satellite service". The broadcasting-satellite service is a space service in which signals transmitted or retransmitted by satellites are intended for direct reception by the general public, as opposed to the fixed-satellite service which involves reception by large, high-cost earth terminals requiring extensive ground distribution. Two distinct categories exist in the broadcasting-satellite service; systems that allow individual reception by simple receiving units in homes, and systems which are designed for community reception. In the latter case, there can be group viewing or listening as is planned for India or there can be limited local redistribution by cable or broadcast-TV.

It is important to realize that the satellites in use for commercial international telecommunications today as well as those proposed for commercial U.S. telecommunications are relatively low-power, "point-to-point" satellites of the "fixed-satellite service" kind which deliver signals to and from large, costly earth terminals. By contrast, a recent study by Singh on "Operating Frequencies for Educational Satellite Services" has concluded that it is in the best interests of the U.S. educational community to look to the 2.5 GHz and 12 GHz frequency bands* for use in educational satellite systems, and to encourage the development of high-powered satellites which can broadcast to a large number of relatively small, inexpensive earth terminals. Some restrictions would have to be lifted if suitable uplink frequencies for educational uses are to be available for "two-way" applications, such as "talk-back" television and computer-aided instruction.

A field of considerable interest and importance is that of design and development of low-cost receiving systems. This work is being carried out in the United States both in industry and universities, sponsored by NASA research centers. Stanford University has concentrated on low-cost "front-ends" which receive television signals from satellites and convert them to a form compatible with conventional television sets. Emphasis has been placed on designs suitable for less-developed areas. Washington University is focusing on "multi-channel" front-ends which can be used to receive more than one television channel and which can be fed into cable television systems for ground distribution here in the U.S. In India, the design and local production of television sets which can operate reliably in regions in which electric power is not available is a particularly challenging and important problem.

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*A GHz or "gigahertz" is one billion Hertz or one billion cycles per second. These frequencies are in the so-called "microwave" region of the electromagnetic spectrum as opposed to the lower VHF and UHF frequencies used in conventional broadcasting. Martin's book on "Future Development of Telecommunications" is helpful in explaining these definitions and concepts.

III. NON-TECHNOLOGICAL ASPECTS;

ECONOMIC, SOCIAL, ORGANIZATIONAL, POLITICAL AND LEGAL FACTORS

The creation of a powerful, new technology such as satellite technology presents new opportunities and generates new problems. It is often said that the primary obstacles to the educational and developmental uses of satellites are non-technological and involve economic, social, political, organizational and legal factors rather than technical ones, although the two categories -- technological and non-technological -- are interrelated. Furthermore, unless these factors are built into the overall systems design, the chances of proper utilization are lessened and the chances for misuse of the technology are increased.

First, let us consider the problems that arise within the boundaries of one country, the United States. Although there has been considerable interest in the use of technology in education over the past decade, the current state of utilization is rather low and leaves much to be desired. A communications satellite by its nature requires large information flows over long distances to achieve economics of scale. There is a degree of resource sharing between institutions (TV programs, computing power, etc.) and cooperation required which is characteristic of the particular technology in question.

On the other hand, U.S. education is local in structure, with a large number of discrete, non-interacting units. Some possibilities for cooperation and sharing exist through organizations such as the Public Broadcasting Service, U.S. Office of Education, Joint Council on Educational Telecommunications, Western Interstate Council on Higher Education and National Instructional Television, to name only some. The educational satellite systems designer must take into account the realities of the educational system and somehow reconcile the centralized, cooperative nature of the technology with local interests and control. Alternatively, he can consider trying to go around the schools in new innovative ventures for both non-formal as well as formal education in such areas as child development, high school equivalency, career education, etc.

A fundamental issue at a time of teacher surpluses, severe strain on educational budgets and a possible major shift in the overall educational funding base, is whether large-scale use of educational media distributed by telecommunications can find acceptance in the instructional, research and administrative functions of U.S. education. Questions of supplementing versus replacing teachers; using optimum mixes of teachers, media and paraprofessionals; increasing productivity through use of technology are receiving increasing attention and have considerable bearing on future utilization of telecommunications in education.

The issue of the organization and administration of a satellite based, instructional system is an important one which has received relatively little attention. In 1968, an interdisciplinary faculty team developed a preliminary design for "EDUSAT, an Educational Television Satellite System for the United States in the Mid-1970's". A preliminary technical system design was performed and consideration was given to the organization, management and funding of an educational satellite corporation which encompassed public, special and instructional television. The Board of Directors of the non-profit EDUSAT corporation was to be made up of major interests involved in educational media. Relatively little attention was paid to software quality, availability and production requirements as well as to other factors which might promote or impede the acceptance of an educational satellite system by teachers and school administrators.

Sheppard has proposed an "Instructional Communication Satellite System for the United States" involving seven synchronous satellites. In his work, the country is divided into fifteen regions each containing one to six states with roughly equal numbers of pupils. Each region would have the capability for a minimum of one TV channel plus data capacity to allow one terminal for computer-assisted instruction (CAI) for every 25 students. In contrast to the EDUSAT study, Sheppard broadens the range of instructional media and information which might be delivered by a satellite to include other than television programs although he by no means exhausts all possibilities. His study focuses on hardware and media requirements and costs. Some consideration is also given to social and political factors which arise from potential conflicts between local and state educational control and the assumed equipopulation regions in Sheppard's system.

In addition to the studies described above, there have been a number of proposals made in recent years by various organizations for using communications satellites in the United States both for commercial and noncommercial purposes. In 1966, in response to a Notice of Inquiry by the Federal Communications Commission (FCC) concerning domestic communications satellite facilities, the Ford Foundation proposed a Broadcasters' Non-Profit Satellite Service for distributing both commercial and non-commercial radio and television programming. A broadcast program distribution satellite system was contemplated to serve commercial as well as public television networks with the commercial networks subsidizing public program distribution. However, the production of instructional programming, that is programming designed for use in the schools, would not be included in this arrangement.

More recently, the FCC solicited proposals to establish and operate domestic satellite facilities, requiring that applicants state terms and conditions for providing services to non-commercial broadcasters and educational institutions. A summary of their public service responses and some remarks concerning the extent to which such proposals meet public broadcasting requirements has been presented by Singh and Morgan in their study of educational information dissemination services. National public broadcasting organizations have emerged as a result of the Public Broadcasting Act of 1967. These organizations, National Public Radio and Public Broadcasting Service, have set forth their requirements for satellite channels. However, because of the local nature of U.S. education, the definition of requirements and opportunities for instructional media and telecommunications in the schools is a more difficult problem. Media and telecommunications for instruction are a major concern of the U.S. Department of Health, Education and Welfare, and Office of Education which is initiating studies of U.S. educational telecommunications requirements. Such studies are also an element of the program at Washington University on Application of Communications Satellites to Educational Development.

At Washington University, a number of organizational and administrative schemes are being considered. One concept involves a cooperative public-private sector effort in which a non-profit instructional satellite corporation controls the satellite but in which software is made available to schools on a competitive basis. This latter study examines educational, political, social and economic design considerations as well as the possible impact of such a system on U.S. education. The phased establishment of ground distribution systems prior to interconnection by satellite has been explored in an economic study by Barnett and Denzau entitled "Future Development of Instructional Television".

Other important non-technological aspects being studied in the Washington University Program include legal restrictions which might be imposed by the proposed revision of the copyright laws which could severely limit the free flow of educational materials in telecommunications systems. The particular question of how communications technology may be applied to foster equality of educational opportunity has been a constant concern. Also being considered are strategies for bringing educational telecommunications systems into being and the long-range impact of those systems on education, if and when they are established.

Other issues of concern include the nature, quality and quantity of software (programming), including its suitability for local versus regional versus national use; requirements for access to information by teachers and students within a given time frame; methods of financing instructional telecommunications systems; requirements for billing and for installation and maintenance of equipment; federal subsidy without federal control of program content.

On the international level, issues arise in addition to those already mentioned. These include "spillover" of unwanted signals in direct broadcasting from one country to another, international legal and copyright issues, and the issue of "cultural imperialism". The use of satellites both for U.N. peacekeeping and for international technical assistance has been proposed. In these latter instances, the satellite as a spur towards fostering regional and international cooperation is highlighted. Some people believe that the development of new and effective systems for education, making use of satellites and related technology, could result in substantial improvements in the educational capability of nations as well as better methods of international cooperation. Others feel that the rapid spread of new communications technology could result in the squandering of precious foreign exchange by less-developed countries, social upheaval, and the extension of centralized political control by repressive governments. A somewhat middle-of-the-road view in the book by SIPRI on "Communications Satellites" holds that, "The dangers of communication satellites, in terms of propaganda, and political or cultural hegemony, appear to have been exaggerated, and so do the hopes vested in such development as a rapid breakthrough in educational television in the under-developed countries."

In planning for use of satellite technology in less-developed countries, questions of language diversity, availability of trained manpower, supporting physical infrastructure for communications and availability of financial resources versus other developmental needs all require careful consideration.

IV. EDUCATIONAL AND DEVELOPMENTAL USES OF SATELLITES

The uses currently contemplated for communications satellites in educational development are indeed diverse. Among the potential educational uses for satellite-based services in the United States are primary and secondary school instruction, instruction and research in institutions of higher learning, vocational education, inter-library services for resource sharing and remote information retrieval, continuing education for adults and professionals, public television and radio, special television services for ethnic and professional groups, and educational administration. As an example of special professional services, the Lister Hill Center for Biomedical Communications of the National Library of Medicine is involved in experiments utilizing satellites for medical diagnosis and continuing education of medical professionals in remote areas.

The educational development aspects of satellite utilization refer to the potentials for bringing educational telecommunications services to areas and/or groups now inadequately served such as Alaska, Appalachia and the Rocky Mountain States. In India, developmental aspects include plans for dissemination of information as part of family planning, agriculture, and community development programs, in addition to more formal educational uses. Brazil's extensive satellite planning effort emphasizes programming to be used in formal education in the remote, less-developed area of the Northeast.

The satellite is a part of an educational telecommunications system which receives signals from the ground and disseminates the signals over designated areas (See Figure 1). The educational media which could be transmitted via satellite include public and instructional television and radio, still-picture television and facsimile, and digital data for use in computer-aided or managed instruction, as well as remote computing for instructional, research or administrative purposes. Many of these media are likely to be part of experimental satellite transmission in the 1970's.

In the United States, communications satellites are likely to represent one segment of an educational telecommunications mix. There is a great deal of interest now in utilizing cable systems for educational television in urban areas. The Instructional Fixed Television Service, microwave, telephone, and UHF and VHF broadcast systems provide a variety of such services. Much attention for future educational satellite utilization is focusing upon the delivery of media on both a one-way and two-way basis to schools and home in remote areas and on using satellites to interconnect cable television headends. Satellites may have a role in one-way services such as television broadcasts, in interactive services such as television with voice feedback and computer-aided instruction, and in computer interconnection services linking computer to computer for time-sharing. At Washington University (St. Louis) these services have been identified in the course of an interdisciplinary research program we have undertaken on application of communications satellites to educational development. Our work is now focusing upon the detailed specification of satellite-based educational systems for delivering these services during the period 1975-1985 and upon assessing the impact of these systems on U.S. education.

One possible avenue for involvement of the educational community in satellite-based information transfer in the U.S. is afforded by the commercial domestic satellite proposals. Currently, there are eight filings before the U.S. Federal Communications Commission by commercial concerns to own and operate domestic communications satellite systems. Each respondent was asked to spell out the public service offerings which would be made available to the educational community. Included in such offerings were the provision of services for the Public Broadcasting Service as well as for instructional television and computer-aided instruction. Some of the limitations of the domestic satellite systems for education, involving the use of costly ground stations, have been pointed out in Washington University research reports.

The 1970's will see the first television "broadcasting" from space. NASA's Advanced Technology Satellite - F, scheduled for launch in 1973, will flight-test an 80 watt, 800 MHz transmitter which will be used for community TV experiments in India. ATS-F will also carry and flight-test 2.5 GHz 15-watt transmitters for satellite ETV transmissions directly to public broadcast stations for rebroadcast, to cable-television system headends in remote areas in Montana and Wyoming, and to rural schools located in the Rocky Mountain region and Alaska. In combination with a 30-foot diameter deployable antenna aboard the spacecraft, these transmitters will provide enough power to permit use of low-cost receiving terminals. NASA is also planning to flight test a 200 watt, 2.5 GHz transmitter on ATS-G, scheduled for launch in 1975-1976, which will provide multi-channel broadcasting capability.

The Canadian Communications Technology Satellite (CTS), scheduled for launch late in 1974 with NASA's cooperation, will also experiment with multi-channel TV transmissions in the 12-GHz band for community type reception. Its proposed list of experiments includes broadcast of aural signals to a selected region. Both the U.S. and Canada are expected to make use of the satellite capacity.

Demonstrations and experiments with NASA's ATS-F and -G and Canada's CTS satellites are bound to stimulate greater interest in the development and deployment of domestic as well as regional high-power satellite systems and, in particular, those for television and aural broadcasting to community installations for group viewing and/or limited local redistribution. Though currently there are no plans in the U.S. and Canada for such an operational system, it is not unlikely that in the mid and late 1970's, high-power satellite systems capable of feeding a large number of TV channels directly to low-cost broadband terminals at cable headends will see deployment. In the United States, satellites may be used for direct or indirect distribution of public and/or instructional television and radio programs to ground broadcast stations, CATV headends, school roof-tops and community centers.

Abroad, India has already plans to follow-up the ATS-F community-TV experiment with an operational satellite system to be known as INSAT. Brazil is also planning a satellite system of her own that will provide for direct reception of satellite signals by school roof-top installations. France has already prepared an elaborate plan for satellite TV distribution and broadcasting in the French-speaking African countries, and there also seems to be considerable interest in a 12-GHz satellite broadcast system for the western European countries. At least some of these may very well see actual deployment in the 70's.

Recently, attention has been paid to the non-broadcast potentials of future high power satellites for providing two-way communications with small-terminals capable of maintaining narrow-band (e.g. voice and digital data) uplinks and receiving broadband (e.g. television) signals. Instead of visualizing satellites as a means for one-way delivery of educational broadcast material, educational interests have begun thinking of satellites increasingly in terms of a means for networking of educational institutions and resource centers. Interest in networking of educational institutions and resource centers has been prompted by the possibilities of the sharing of administrative, research and instructional resources for efficient utilization of the limited monetary resources available to the education sector. In addition, there is interest in the use of satellites for providing students and teachers in remote and isolated institutions equitable access to services such as computing, computer-based instruction (CBI), etc. that are currently more readily available to their counterparts in large urban and suburban areas.

Interest has also been expressed in using satellites for making available to doctors everywhere in the United States the medical information at medical libraries and information in particular fields, such as tropical diseases and poison control, which is now available to physicians in large teaching hospitals in metropolitan areas.

The high-cost of present long-distance telecommunications have resulted in their scant use by U.S. educational institutions. A Stanford Research Institute study has projected only a small decrease in the long-distance telephone line costs for the 1970's because the increases in the local plant costs are expected to continue to offset the reductions in the long-haul transmission costs. Low-power satellites requiring complex and high-cost earth-terminals, operating in frequency bands with severe power flux limitations and colocation problems*, and working in conjunction with the present terrestrial plant do not present opportunities for any significant cost reductions. To effect large reductions in the price of long-distance, toll TV, or voice/data service, it appears necessary to develop high-power satellites capable of working with small ground stations placed within population centers -- that is, a system that bypasses much of the present surface facilities.

There is little in the form of published literature on educational, small-terminal, interactive satellite services. However, it is recognized that the economics is such that only narrow-band uplinks, (that is, for

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*That is, problems basically of interference with existing ground services.

voice and digital data, not television) would be realizable from low-cost terminals. In an educational environment, the uplink transmissions are expected to contain user responses such as those involved in CAI interaction and opinion polling, voice feedback to a central point, and certain limited user-initiated links such as those for information retrieval (in voice, narrow-band data and facsimile form) and teleconferencing.

There has been some exploratory work on the systems and economics aspect of satellite delivery of CBI and raw computing power to remote institutions. The large propagation delay* involved in geostationary satellite communications circuits is recognized as a major problem in that it contributes to the computer response time and presents difficulty in the implementation of conventional feedback error correction and detection coding. The large propagation delay is regarded as particularly objectionable in certain computer-to-computer communication situations as well as in interactive computing systems that involve character-by-character transmission and where each character appears on the teletype or display after "echoing back" from the central processor, as is the case with the current Plato system at the University of Illinois. The earth-terminal cost is recognized as the major element of the system cost and it is suggested that the earth-terminals be of the multi-purpose type and should incorporate the satellite television broadcast reception function to dilute the cost for any particular service.

As far as actual experiments are concerned, in the summer of 1970, Stanford University demonstrated the feasibility of satellite computer-assisted instruction (CAI) delivery to nine terminals at a single elementary school through NASA's ATS-1 experimental satellite. The experiment used the satellite to deliver CAI lessons, and responses were transmitted to the computer using telephone company facilities. ATS-1 is currently being used in Alaska to provide two-way experimental links for biomedical communications purposes. The forthcoming ATS-F/G educational experiments for the U.S.A. will approximate closely the likely operational situations in the 2.5 GHz frequency band involving small interactive

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*It takes about one-quarter of a second for a signal to travel from the earth to a synchronous satellite and back again.

terminals for providing CAI and voice-feedback along with television programming in addition to point-to-point and area coverage narrow-band links for biomedical communications.

V. GUIDE TO SELECTED LITERATURE

Chapter VII of this paper presents a bibliography on application of communication satellites to educational development (technology, systems, and experiments) for non-specialists. In this section, an attempt is made to describe briefly some selected references which should give the reader a broad overview of the literature in this field. This section is divided into three categories: Satellite Technology and Systems; Non-technical Aspects -- Economic, Social, Organizational, Political and Legal Factors; and Educational Development Applications. More complete citations can be found listed alphabetically by author in Chapter VII.

SATELLITE TECHNOLOGY AND SYSTEMS

Future Developments in Telecommunications (Martin, 1971) is an excellent general introduction for both the technical and non-technical audience to telecommunications technology. Its section on "communications satellites" is informative and easy to understand. It also contains a useful glossary of terms.

Communication Satellites (SIPRI, 1969) provides a brief, readable non-U.S. view of the potentials and problems associated with communication satellites. It contains a short, understandable technical section.

Satellites for Television Distribution (Jaffe and Silverman, 1971) provides a readable historical analysis of communication satellite development and describes new NASA initiatives for education-oriented experiments.

Communications Satellites for the 70's: Systems (Feldman and Kelly, 1971) contains a collection of papers presented at the 3rd AIAA Communication Satellite Systems Conference, April 1970. Of particular interest are the preface by the editors that calls for new research and development initiatives in the arena of high-power satellites and the sections on systems for emerging nations and the U.S. A companion volume edited by the same authors is Communications Satellites for the 70's: Technology.

Communications in the Space Age: The Use of Satellites by the Mass Media (UNESCO, 1968) is a collection of papers based on a 1965 UNESCO Conference. Papers cover a broad spectrum of topics primarily aimed at international utilization. Some of the papers are slightly out-of-date but provide easy reading for non-technical readers.

Useful Applications of Earth Oriented Satellites: Broadcasting (National Research Council, 1969) explores opportunities, system choices and feasibility for direct broadcast satellites.

Broadcasting-Satellite Service: Technical Considerations (United States Delegation to U.N., 1969) is an interesting document that examines the technological feasibility of a variety of broadcast satellite services.

Television Broadcasting Satellite Possibilities (Andrus, 1971) examines the technological factors for community reception-type broadcast satellites and forecasts the technological feasibility of such systems by the mid-70's.

Operating Frequencies For Educational Satellite Services (Singh, 1971) discusses the frequency assignments for Fixed- and Broadcast-Satellites and the implications of the use of various frequency bands for educational purposes.

Directions and Implications of Communication Technology (Kuhns, 1970) presents a readable discussion of the implications and potentials of NASA communications technology development programs. The specific technology areas discussed include: low-cost receivers for direct satellite broadcasting, high-efficiency microwave tubes, shaped antenna beams and orbit and frequency sharing.

Satellites and Technology for Communications: Shaping the Future (Hult, 1968) and Satellites for Future Communications, Including Broadcast (Hult, 1967) discuss the potential application of communications satellites and presents the outlook of a futurist.

Assessment of Space Communications Technology (U.S. House of Representatives, 1969) focuses on domestic applications of satellites with emphasis on Alaska.

An Evaluation of Television Broadcast Satellites (Hesselbacher, 1969) is devoted to examination of technological and cost factors associated with the various broadcast satellite systems.

NON-TECHNOLOGICAL ASPECTS: ECONOMIC, SOCIAL, ORGANIZATIONAL, POLITICAL, LEGAL AND REGULATORY FACTORS

Communication by Satellite: An International Discussion (Twentieth Century Fund, 1969) emphasizes regulation and coordination of satellite communications; operation and management; avoiding unwarranted broadcasts and international cooperation. A companion volume is the report Planning For a Planet; An International Discussion on the Structure of Satellite Communications (Twentieth Century Fund, 1971).

The Future of Satellite Communications; Resource Management and the Needs of Nations (Twentieth Century Fund, 1970) discusses the issues related to efficient utilization of spectrum and orbit resources.

Direct Broadcast Satellites and the Right to Communicate (d'Arcy, 1969) focuses on some of the philosophical and regulatory issues involved in the establishment of direct broadcast satellite systems.

Broadcast Satellites: Their Potential Use For Educational Purposes and Their Relationship to International Understanding and Cooperation (Hanessian and Margolin, 1969) provide a good account of some of the crucial issues involved in utilizing satellite technology and the application gap that exists between the technology and the plans for its utilization.

Broadcast Opportunities With Satellites and CATV, and Their Control in The Public Interest (Hult, 1970) attempts to alleviate international concern about the control of satellite broadcasting and proposes new regulatory and operational policies for the newly emerging opportunities.

CPB Comments in the Matter of Domestic Communication Satellite Facilities (Corporation For Public Broadcasting, 1971) discusses the position of education interests, primarily CPB and PBS, on obtaining reduced- or no-cost satellite channels from prospective commercial satellite system operators and also reflects some of the differing opinions on the matter.

A detailed bibliography on the legal and copyright issues related to satellite program distribution services is available from EDSAT Center, University of Wisconsin, Madison, Wisconsin.

EDUCATIONAL AND DEVELOPMENTAL USES OF COMMUNICATIONS SATELLITES

Les Satellites d'Education [Educational Satellites] (CNES, 1971) is a collection of papers presented at an international conference on educational satellites in Nice (France) in May, 1971. It contains papers on satellite applications in India, Latin America, and Africa. Some of the papers contained in it are in French. The volume includes papers by representatives of UNESCO.

Broadcasting From Satellites: A Powerful Potential Aid to the New or Developing Countries (Rao and Froom, 1971) discusses the benefits of satellite television for developing nations and describes India's plans for an operational satellite system.

Satellite Instructional Television Experiment (Kale, 1971) provides the technical and organizational details of a joint NASA-India satellite ITV experiment using ATS-F satellite that is planned for 1974.

Systems For Emerging Nations: An Overview (Morgan and Margolin, 1971) summarizes the status of planned or proposed applications of satellite television in the developing countries and the issues involved in adoption of satellite-based telecommunication systems.

Satellites For Television Distribution (Jaffe and Silverman, 1971) describes NASA's plans for flight-testing high-power transponders on ATS-F and -G Satellites for educational demonstrations.

Communications Satellites, Technology Transfer, and Economic Development (Jordan, 1970) has derived a simple model relating economic development in emerging nations to education and the level of applied technology.

Planning the Use of an Instructional Satellite (Jamison, 1970) focuses upon the issues related to the allocation of resources to a number of competing technologies and media, and upon the optimal use of satellite communications capacity.

Satellite Communications for U.S. Schools (Krause, 1971) presents an interesting discussion on potential non-broadcast satellite applications in education and describes MCI-Lockheed Satellite Corporations offer for limited free satellite channel capacity for educational telecommunications.

Program on Application of Communications Satellites (Morgan and Singh, 1971) discusses new opportunities provided by satellites for educational telecommunications and information networking, probable near-term, economically viable satellite-based services, and the options for educational satellite systems in the U.S.

An Instructional Satellite System for the United States (DuMolin and Morgan, 1971) discusses the organizational and other non-technological aspects of a large-scale instructional satellite system in the U.S. educational and political environment.

An Investigation of Network Television Distribution (Dysinger, 1971) presents the results of a study conducted for the Public Broadcasting Corporation for the delivery of educational television programs to affiliate broadcast stations and instructional centers. It discusses the cost of systems with different channel capacities and different operating frequencies and concludes in favor of a large capacity system.

Educational Computer Utilization and Computer Communications (Singh and Morgan, 1971) presents a survey of the current status of computer utilization in education for a wide-range of applications and analyzes the prospects for increased reliance on communications in the future, particularly for providing rural and isolated institutions certain computer services and for high-speed interconnection of computers. Possible roles for satellites for educational computer data transmission are discussed along with the question of economic viability of such services.

Future Development of Instructional Television (Barnett and Denzau, 1971) describes a four-step strategy for developing instructional television and analyzes the roles of various transmission media, including video cassettes and cable television, in the various stages of development.

VI. ORGANIZATIONS, AGENCIES, INFORMATION SERVICES

A. GOVERNMENT, INDEPENDENT AGENCIES AND ORGANIZATIONS CONCERNED WITH THE USE OF SATELLITES FOR EDUCATION

The following organizations are concerned with the future utilization of communications satellites for education and/or public health purposes. A brief description of their nature and activities is provided to give an idea of their involvement in this area. A tactful letter, stating your particular interests, may result in your being sent a recent progress report, informative brochure or technical paper.

Corporation For Public Broadcasting (CPB), 888 Sixteenth Street, N.W., Washington, D. C. 20006. John W. Macy, President. CPB was established by Congress in 1967 as a non-profit, non-government corporation to promote and help finance the development of non-commercial radio and television. This includes providing a national interconnection of stations generating quality programming from many sources and to support the total public broadcasting system through activities such as talent development, encouragement of innovative techniques, audience research and public information. CPB's interest in communication satellites lies in the possibility of low-cost interconnection of public radio and television stations in the nation and the potential to reach communities in rural and remote areas through small, inexpensive stations. CPB's involvement in satellites dates back to the early 1960's. In June 1969, it organized a public broadcasting task force on satellites to evaluate and optimize the performance of a transcontinental satellite link for video interconnection and the feasibility of interference-free television reception from satellites by medium-size receiving stations in an urban environment. This task force proposed a series of experiments on NASA's Advanced Technology Satellite - I and -III which lasted from January 4, 1970, until March 26, 1970. Along with the Department of Health, Education and Welfare, CPB is a co-sponsor of a major satellite experiment that is planned for the summer of 1973 for the Rocky Mountains at 2500 MHz using NASA's Advanced Technology Satellite - F.

Joint Council on Educational Telecommunications (JCET), 1126 Sixteenth Street, N.W., Washington, D. C. 20036. Frank W. Norwood, Executive Secretary. JCET is a consortium whose membership now includes more than twenty of the nation's leading non-profit organizations in education and communications. The JCET was originally established in 1950 to provide leadership in persuading the Federal Communications Commission to reserve television channels for non-commercial broadcasting. Today, JCET serves in the arena of communications policymaking as education's established instrument for coordination and participation. During the past year, the JCET called the attention of the educational and public broadcasting community to the potentials of 2500 MHz frequency band for educational satellite communications. The JCET has been active in drawing education interests' attention to the potentials of satellites and in seeking education's access to channels on future commercial domestic satellite systems. The JCET News is the official newsletter of the Commission and is published every month for distribution to member organizations. It mentions proposed legislation, meetings, significant news events and opportunities in the area of educational telecommunications.

Office of Telecommunications Policy, Department of Health, Education and Welfare, 330 Maryland Avenue, S.W., Washington, D. C. 20202. Dr. Albert L. Horley, Director. OTP-HEW was created in the Fall of 1970 to coordinate the department's communications policy-making and for representation of its interests. OTP played a major role in persuading the Federal Communications Commission to modify its position with regard to 1971 World Administrative Radio Conference (Geneva) and to include the 2500-2690 MHz frequency band for educational satellite broadcasting and other satellite-based telecommunications in the United States position. OTP-HEW is also coordinating DHEW's efforts in joint DHEW-CPB, ATS-F educational experiments and in seeking the assistance of the National Aeronautics and Space Administration (NASA) in exploring a wide range of technical possibilities as well as in conducting studies with regard to the social, economic, and technical applicability of space technology.

The Lister Hill National Center for Biomedical Communications, National Library of Medicine, National Institutes of Health, Department of Health, Education, and Welfare, Bethesda, Maryland 20014. Dr. Al Finer, Director. The long-term goal of the Lister Hill Center is to provide improved health care to all citizens by combining the technology and resources of telecommunications with those of library science, computer applications and medicine. To this end, Lister Hill Center has funded a number of studies to investigate the potential applications of communications satellites for patient information, diagnosis and transmitting medical treatment plans. Other uses include continuing education of medical professionals in rural and remote areas and providing them access to distant information resource centers. Lister Hill Center is coordinating the biomedical communication experiments using NASA's ATS-F satellite that will focus on health care and education in rural and remote areas and provide information to serve as a data base for the design of future operational systems.

The National Center for Educational Technology (NCET), U.S. Office of Education, Department of Health, Education, and Welfare, Washington, D. C. 20202. Dr. John Cameron, Director. The goal for NCET, a creation of the recent restructuring of the Office of Education, is to bring advances in technological achievement to bear on the problems of improving education for all citizens at all levels. The applications of technology are intended to increase both the quantity of people being educated and the quality of education they are receiving. To this end, NCET is interested in exploring the opportunities offered by communications satellites for helping to solve educational problems of rural isolated and rural dense population areas. A number of projects have been sponsored by the Office of Education to define applications for communications satellites for certain regions (Appalachia, Rocky Mountains, and Alaska) and to design experiments based on NASA's ATS-F and -G satellites to obtain data for future decision-making.

Communication Programs, Office of Space Applications, National Aeronautics and Space Administration, 400 Maryland Avenue, S.W., Washington, D. C. 20546. Dr. Richard Marsten, Director. Office of Communications Programs (NASA) has over the years been concerned with research and development related to new, innovative applications of space communications technology. It has sponsored a number of systems studies to investigate the technological and cost factors associated with the development of high-power satellites capable of serving low-cost terminals and has funded a number of developmental efforts in the area of satellite as well as earth-terminal technology. Its systems engineering section is responsible for developing future user needs for the new technology in cooperation with user agencies and translating them into system possibilities. In cooperation with NASA's Office of University Affairs, the Office of Communications Programs has funded a major effort at Washington University in Saint Louis for defining user requirements and new opportunities in the education arena as well as for investigating the economic, social and political factors associated with the various system possibilities. This NASA office is also responsible for coordinating, on NASA's side, the planned ATS-F educational experiments in the summer of 1973 and the joint NASA-Government of India ITV experiments in 1974. It is also planning to flight-test a powerful space-borne repeater on ATS-G satellite for a variety of educational experiments and is also looking after the joint United States-Canada Communications Technology Satellite (CTS) project scheduled for launch in 1974.

National Association of Educational Broadcasters, 1346 Connecticut Avenue, N.W., Washington, D. C. 20036. William G. Harley, President. NAEB is an association designed to serve the professional and membership needs of educational radio and television stations, systems, and personnel. It is a means for cooperative action among its members. It publishes a bi-weekly Newsletter, the bi-monthly Educational Broadcasting Review, professional monographs, conference reports and an annual Yearbook/Directory. It is active in promoting the use of communication satellites as a means for networking of stations and for direct broadcasting of television and aural material to rural and isolated population centers.

National Education Association, 1201 Sixteenth Street, N.W., Washington, D. C. 20036. Donald E. Morrison, President. NEA is a leading organization representing teachers and school administrators in the United States. They have maintained an active interest in the field of educational technology, under the leadership of Harold Wigren, Associate Director of their Division of Educational Technology. NEA has been exploring the possibility of using ATS-F and -G satellites in rural and isolated areas for teacher development.

National Public Radio (NPR), 888 Sixteenth Street, N.W., Washington, D. C. 20006. Donald R. Quayle, President. NPR is a membership organization designed to provide a national programming service and operate a network distribution system for public radio stations of the country. Its members are licensees of nearly 100 non-commercial radio stations and include colleges and universities, non-profit public broadcasting corporations, public school systems, and municipalities. Its interest in satellites lies in the possibility of low-cost interconnection of radio stations capable of handling high-fidelity stereo signals and for extending program coverage to rural and isolated areas.

Public Broadcasting Service, 955 L'Enfant Plaza South, S.W., Washington, D. C. 20024. Hartford N. Gunn, Jr., President. PBS is a private, non-profit corporation chartered in November, 1969 in Washington, D. C. to select, schedule and promote national programs and to distribute them to the country's 204 non-commercial television transmitters. It is a user-controlled distribution system and is responsible to the stations it serves. PBS has shown considerable interest in the use of communication satellites for program delivery to affiliated stations and educational institutions as well as for program assembly from a number of widely separated points. It has been very active in the current domestic satellite proceedings before the Federal Communications Commission to secure cost-free channels for public broadcasting use as a dividend to the public for their 22 billion dollar investment in the space program. It has also funded a major study (Dysinger, 1971) to investigate interconnection possibilities and cost factors associated with direct distribution satellites in frequency bands of near-term interest.

B. U.S. GOVERNMENT AGENCIES CONCERNED WITH REGULATION OF DOMESTIC COMMUNICATION SATELLITE SYSTEMS

The following two U.S. agencies are concerned with the policy-making and regulatory aspects of all telecommunications activities -- governmental as well as non-governmental. They occasionally issue public notices or news releases on issues of significance to educational telecommunication activities -- current or prospective. Often the results of the deliberations and decisions of these agencies are covered by Telecommunications Report (a weekly newsletter) and the weekly newsmagazine "Broadcasting". A letter to these agencies would help to get detailed information on the proceedings and deliberations of concern.

Federal Communications Commission, 1919 M Street, N.W., Washington, D. C. 20554. Honorable Dean Burch, Chairman. FCC is charged with the regulation of all non-governmental telecommunications activities and systems. One of its Commissioners, Hon. H. Rex Lee, is specifically assigned the task of looking after educational telecommunications activities. In the area of educational satellite communications, the FCC took a major step in recognizing new opportunities when it modified the U.S. position for the World Administrative Radio Conference to include the 2500-2690 MHz band for educational satellite telecommunications. Currently it has eight applications under consideration for authorization to construct domestic commercial communication satellite facilities (Docket 16495). One of the major questions in these proceedings is whether or not to require prospective domestic satellite operators to provide satellite channels to educational broadcasters on a reduced- or no-cost basis as a dividend to the public for its investment in the space program.

Office of Telecommunications Policy, Executive Office of the President, Washington, D. C. 20504. Dr. Clay T. Whitehead, Director. In the early 1960's, President Kennedy established an Office of Telecommunications Management (OTM) to regulate the governmental telecommunications systems and radio frequency spectrum usage. In 1970, President Nixon gave this office an enlarged scope to include national telecommunications policy-making and representation of the views of the executive wing of the national government in overall policy-making. From the beginning, OTP has shown its fondness for a competitive and unregulated approach for bringing domestic satellites into operation and permitting virtually anyone with the necessary technical and monetary resources to operate a system. OTP has already formulated its recommendations in the matter of domestic satellite proceedings and has commented unfavorably on the proposition of reduced- or no-cost satellite channels for educational broadcasters. In the event that a need for a dedicated satellite system for educational and medical purposes is felt, the OTP is likely to play a major role in the decision-making and, particularly, the organization and financing of the system.

C. PROFESSIONAL ORGANIZATIONS AND INFORMATION SERVICES

Professional organizations which periodically sponsor conferences or conference sessions on satellite systems and applications and publish proceedings or monographs are listed here along with relevant information services.

Association for Educational Communications and Technology, 1201 Sixteenth Street, N.W., Washington, D. C. 20036. Robert C. Gerletti, President. AECT is a professional organization of 10,000 plus individuals active in planning, application, and production of communication media for instruction. AECT (formerly the Department of Audiovisual Instruction, National Education Association) is broadening its scope to encompass new developments in communication and information technology. Though none of AECT meetings have had any sessions on the application of communications satellites for education to date, it seems likely that future meetings and publications would focus attention on the utilization of the potentials of communications satellites. Audio-Visual Instruction is AECT's official monthly. AECT also publishes a scholarly quarterly journal, AV Communication Review.

American Institute of Aeronautics and Astronautics (AIAA), 1290 Avenue of the Americas, New York, N.Y. 10019. AIAA has been sponsoring bi-yearly conferences on Communication Satellite Systems. The first conference was held in 1966, the second in 1968, the third in 1970 and the fourth one is scheduled for April 1972. Most of the papers are preprinted and are available from the AIAA for $1.50 each. Selected papers from the 1966 and the 1970 conferences have also been published in book form in the AIAA Progress in Aeronautics and Astronautics Series (Volumes 19, 25, and 26). In addition, many papers relevant to educational applications of satellites are also presented in various other meetings sponsored by the AIAA -- to name a few, the Space Systems Meeting, Annual Meeting and Technical Display, etc. AIAA publishes a monthly bulletin titled AIAA Bulletin that carries meeting programs, including paper titles and 100 word abstracts, announcements of future meetings, and other news relevant to AIAA meetings. AIAA also operates a technical information service (at 750 Third Avenue, New York, N.Y. 10017) from which one can order AIAA papers and certain other materials relevant to aeronautics and astronautics.

Institute of Electrical and Electronics Engineers, Inc., 345 East 47th Street, New York, N.Y. 10017. IEEE sponsored meetings, particularly the International Conference on Communications (ICC), International Telemetry Conference (ITC), International Convention, and National Telecommunications Conference (NTC), often includes sessions dealing with communication satellite technology and systems. IEEE Spectrum, a monthly IEEE publication, carries the announcements for future meetings and sessions as well as an advance table of contents of other IEEE publications. The IEEE transactions that carry relevant articles are: IEEE Transactions on Broadcasting, IEEE Transactions on Communication Technology, and IEEE Transaction on Aerospace and Electronic Systems. IEEE has established a Joint Technical Advisory Committee in cooperation with the Electronic

Industries Association (EIA) that is concerned with the effective use of the radio spectrum. Some of the JTAC reports have focussed upon radio spectrum utilization for space services.

The Institution of Electrical Engineers (IEE), Savoy Place, London, W.C. 2, U.K. IEE has over the years sponsored a number of conferences on communication satellite technology, techniques and systems. Conference papers are available in form of a conference proceedings from IEE Publications Department. In addition, IEE has also published relevant monographs and included communication satellite related papers in its monthly publication Proceedings IEE.

NASA Scientific and Technical Information Facility, P.O. Box 33, College Park, Maryland 20740. NSTIF publishes Scientific and Technical Aerospace Reports (STAR), a semimonthly abstract journal with indexes and abstracts covering worldwide report literature on the science and technology of space and aeronautics. Its section on Communications has often contained entries on the systems aspects of communications and broadcast satellites. STAR also lists the place of availability of the entries individually and contains addresses of organizations from whom the reports could be obtained.

D. ADDITIONAL INFORMATION

We wish to briefly make mention of some additional sources of information and organizations which have interest in educational uses of satellites. Although the information we present is incomplete, some detective work on the reader's part will very likely yield results.

In the field of international uses of satellites for educational and developmental purposes, the principal agency of the United Nations with responsibility in this area is UNESCO, Place de Fontenoy, Paris, France. UNESCO puts out a variety of publications. The International Telecommunications Union (ITU), located in Rome is a good source of technical information (CCIR Reports) and publishes a journal, "Telecommunications Journal". The United Nations also has a Working Group on Direct Broadcast Satellites which is headquartered in New York.

The principal U.S. governmental agency concerned with use of educational communications satellites in less-developed areas is the Agency for International Development, (AID), Washington, D. C. AID has sponsored a number of studies for which reports are available. NASA's Office of International Affairs may also be of assistance.

A number of U.S. corporations have shown interest in satellite utilization for education in recent years. These include COMSAT, Fairchild-Hiller, MCI-Lockheed, Hughes Aircraft, General Electric. Non-profit organizations include the Rand Corporation and the Academy for Educational Development.

U.S. universities with active programs in the educational satellite utilization field include Stanford, Wisconsin, MIT, Alaska and Washington University (St. Louis). The Wisconsin EDSAT Center is carrying a major bibliographic effort in this field.

There is a growing list of potential educational users for educational satellite experiments. The list includes the Federation of Rocky Mountain Studies, Alaska Educational Broadcast Commission, State University of New York and the Appalachian Regional Commission.

In May of 1971, a Conference on Educational Satellites was held in Nice, France, sponsored by the French Space Research Organization and the French National Commission for UNESCO. A Conference proceedings has been published which is available from the Centre National D'Etudes Spatiales, 129 Rue de L'Université, Paris 7e, France. The proceedings contain papers on satellite studies for potential use in India, Latin America and Africa. Some of the papers are in French.

In July of 1971, a Conference on Satellites for Education was held at Washington University. Present were approximately ninety persons with strong interests in educational satellites utilization. Although no conference proceedings will be available, a list of names and addresses of attendees can be obtained from R. P. Morgan, Box 1106, Washington University, St. Louis, Missouri 63130.

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