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PLANNING ALTERNATIVE ORGANIZATIONAL FRAMEWORKS FOR A LARGE SCALE EDUCATIONAL TELECOMMUNICATIONS SYSTEM SERVED BY FIXED/BROADCAST SATELLITES

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PROGRAM ON APPLICATION OF COMMUNICATIONS SATELLITES
TO EDUCATIONAL DEVELOPMENT

Center for Development Technology
(Communications Group)
Washington University

Memorandum No. 73/3 June, 1973

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JOHN WALKMEYER

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SUMMARY

This memorandum explores a host of considerations meriting attention from those who are concerned with designing organizational structures for development and control of a large scale educational telecommunications system using satellites. Part of a broader investigation at Washington University into the potential uses of fixed/broadcast satellites in U.S. education, this study lays groundwork for a later effort to spell out a small number of hypothetical organizational blueprints for such a system and for assessment of potential short and long term impacts.

The memorandum consists of two main parts. Part A deals with subjects of system-wide concern, while Part B deals with matters related to specific system components.

Part A leads off with a discussion of access. A fundamental rationale for developing a telecommunications-based delivery system is the potential for making more educational resources easily accessible to more people. Accessibility to those resources would be determined by at least four factors. Proximity to system entry points by software distributors and to service points by users is one determining factor. Ability to pay for services is another. Subsidies can lower inability to pay as a barrier to access for the less affluent, but poorly designed subsidies can have unfortunate educational consequences. A third ingredient of access is consent; i.e., permission to use the system's facilities and software. If demand for access to the system exceeds system capacity, apportioning access on a strictly first come basis may not be consistent with educational priorities. Failure to update outmoded copyright procedures threatens to retard development of large scale telecommunications-based delivery systems. Reforms which recognize both the rights of copyright holders and the demands of new information transfer technology have been suggested. A final ingredient of access is control over the conditions of access. Experience has shown pre-scheduling of instructional programming by system operators to be a major deterrent to utilization, one which can be partially circumvented by repetitive scheduling, demand access, and recording for delayed use. Tradeoffs among system costs, complexity, capacity and user convenience must be weighed.

Besides access, another major issue is integration under common control of various system components and functions. While integrated control of stages in the transmission system may be beneficial in terms of the system's viability for a potential operator, concentration of control over programming and transmission facilities may be highly undesirable, particularly if a government operator, with its potential for politicizing information content, is involved.

Numerous alternatives exist for ownership and operation of an educational telecommunications system. Among these are private for-profit corporations, quasi-public non-profit entities, government corporations or agencies, and public-private sector partnership arrangements. In

considering the alternatives, various rationales for past examples of public sector activity should be examined for relevance to educational telecommunications. These rationales include the "public goods" nature of some services, inability to attract private investors, forseeable private enterprise abuses, and potential for public revenues.

Another issue area concerns the control of equipment. Potentially, much of the hardware which would be needed by users of an educational satellite system could be owned by the system operator and either leased or loaned to users. Control of certain user hardware by system operators could promote system technical integrity and financial viability. On the other hand, although some users would no doubt welcome the opportunity to lease rather than buy satellite earth terminals or other equipment, others would resist if the option were a requirement. A degree of support for such resistance can be found in antitrust law and in economic theory.

Strong initiatives are needed to move large scale educational telecommunications, including satellites, from the concept to the action stage. There are numerous development strategies which might be employed. Requiring free or below-cost services to education from the commercial satellite operators would be one such strategy. Financial incentives for private enterprise to undertake development could involve government sponsored R and D, below-cost technical and operational services from NASA and other public agencies, cash operating subsidies, and low-cost loans. In addition, educational telecommunications demonstrations can arouse the interest of prospective users as well as potential private sector developers. The forthcoming ATS-F Rocky Mountain-Appalachia-Alaska demonstration is an example. It would be very useful to conduct additional demonstrations using various financial and organizational support schemes. This would allow both public and private sector planners to observe the viability of educational satellite services under simulated market conditions. So far, however, no such demonstrations are anticipated. Other possible development strategies could involve government development of a satellite system followed by sale to a private operator once sufficient demand has been generated. Various types of marketing assistance from the government could also encourage the private sector.

The issues summarized so far relate to the concept of an educational telecommunications system as a whole. There are still other issues and alternatives which relate to specific components of the hypothetical system. The components given individual analysis in Part B include Program Sources -- Software; Software Storage/Origination Points; Transmission (satellites and earth terminals); and Local/Regional Distribution.

The success of educational telecommunications depends on the availability of high quality instructional television and computer-assisted instruction software. Growth of software inventory has been slow for numerous reasons, including the fact that, with a few exceptions of limited scope such as public broadcasting's children's programming projects, no large scale delivery system or organizational framework has been available

to facilitate the sharing of high software costs by many users. Software and hardware incompatibility, copyright, and lack of adequate communications between producers and educators have also been factors. Government, education and industry each have a unique contribution to make in promoting software development. Education can best perform research. Government can fund R and D activity and promote industry-education cooperation. Industry can best provide packaging and marketing capability. Software could come from a variety of sources. Competitive private industry, user-funded production and procurement consortia, and exchanges of software produced by individual users are prime candidates. The Great Plains and National Instructional Television libraries are existing arrangements that could be major suppliers in a large scale system. So is the developing Special Education Instructional Media Center network sponsored by the Office of Education.

In addition to getting produced, software needs to be gathered at storage/origination points, where it can be readily accessed and relayed through the satellite distribution system. One important issue is how such centers should be arranged to most effectively facilitate software distribution. Among the possibilities are general purpose centers serving separate regions, special purpose centers serving specific educational categories nationwide and combinations of these. Tradeoffs between decentralized control and cost efficiencies are involved in choosing among the options. A conflict between the user's interest in obtaining low cost services and the software distributor's interest in achieving easy entry to the market may be involved in the sizing and technical design of the centers. Various compromises between these interests are possible in the form of administrative controls on entry. The ERIC network for disseminating educational research, multi-state organizations like the Federation of Rocky Mountain States, the Regional Educational Laboratories, distributor consortia and the Carnegie Commission proposal for regional cooperative learning centers all provide different organizational options for control of storage/origination points.

For the transmission component (satellites and earth terminals), three basic options exist: use the forthcoming commercial domestic satellites ("domsats"); develop a system dedicated to educational uses; or develop a "hybrid" of the above, with non-dedicated satellites serving delivery points common to educational and non-educational users, such as CATV headends. The "domsats" will be low-power satellites requiring expensive earth terminals. However, educational networks might capitalize on developing satellite communications technology by being designed with high power satellites serving thousands of low cost earth terminals colocated with final delivery points. A number of administrative options exist -- including a non-profit corporation, operating as either a common carrier or an integrated owner/operator/programmer; a government (TVA-type) corporation leasing out blocks of channels to separate common carriers or user groups; a government-owned system franchised to a private operator; a turnkey system developed by government and turned over to the private sector; or a satellite system owned by a consortium of cable operators.

The final separately analyzed component is local-regional distribution: CATV, Instructional Television Fixed Service (ITFS), broadcasting, common carrier point-to-point and multipoint microwave, FM band subcarrier distribution (SCA), etc. An elaborate terrestrial telecommunications infrastructure already exists in the U.S. It will likely be used to move some satellite traffic from satellite delivery point to final user and from user to satellite uplink point. In addition, a good deal of educational telecommunications traffic patterns are likely to be of a local or small area nature, not involving great enough distances to justify using satellite circuits. In urban areas, distribution of traffic imported by satellite may be more economically distributed by cable television than through receivers at each final delivery point. One possible way of assuring that enough cable capacity would be available to handle satellite-imported traffic would be to develop large capacity cable systems dedicated to education. In local distribution systems, a number of tradeoffs between distribution system capacity and activity at school headends deserve analysis. For example, a 40-channel dedicated cable system could allow frequent repetitions of many programs, so that individual schools would not have to have expensive headend facilities to record programs for delayed playback. Sparsely populated rural areas, where one-fourth of the population resides, have always lacked the abundance of telecommunications services available to urban dwellers. Equalizing educational communications services for rural localities would be extremely costly if accomplished by such conventional technologies as ground-based VHF and UHF broadcasting. Satellites have the potential to improve the situation at a reasonable cost. But, if satellites are to benefit the rural areas, subsidized terrestrial systems of some kind may still be necessary to move the satellite signal from satellite earth terminal to users and, in the case of interactive services, from users to satellite uplink transmitter. The degree of investment needed for such terrestrial systems would depend on the technical configuration of the system.

In addition to dealing with the organizational issues and alternatives discussed above, planners need to maintain on-going assessment of the possible social consequences of educational networking. These consequences may fall into such areas of concern as erosion of privacy by data banks and interactive communications, effects of expanded quantities of accessible information, economic and psychological effects of electronically mediated learning, implications of equalized educational opportunity with (or without) accompanying equalization of social and economic opportunity, impact on employment patterns, and the possibility of excessive standardization.

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INTRODUCTION

1. Purpose and Scope of this Memorandum

Washington University's Center for Development Technology is engaged in a NASA sponsored research program on potential applications of communication satellites to educational development in the United States. This effort has been organized into three main phases: (1) Needs Analysis -- examining the status and trends of U.S. education and defining opportunities to use communications satellites to meet existing and future needs; (2) Communications Technology Studies; (3) Systems Synthesis. This memorandum has been prepared in connection with the systems synthesis phase and represents part of an effort to identify hypothetical alternative organizational frameworks for the control and administration of an educational telecommunications system of national scope, using fixed/broadcast satellites for networking of local distribution plants and remote areas.

A memorandum subsequent to this one will present some specific hypothetical organizational blueprints, including estimates of financial and channel requirements. Currently underway is an analysis of satellite system cost sensitivities to various capacity and service demands, equipment lifetime, coverage patterns, earth terminal populations and growth rate, etc.

To date, the systems systhesis phase has involved work in several areas. Stagl et al. [1], utilizing the Washington University IBM 360/65 computer system, have refined the General Dynamics/Convair communication satellite system synthesis and optimization program to aid in analysis of alternative frameworks currently being developed. Stagl and Singh [2,3] have developed computer programs for plotting satellite spot beam coverages on a computer drawn geographical map. The eight original domestic satellite system proposals have been examined in terms of their suitability for developing educational networking services.[4] A study by Barnett and Denzau[5,6] developed cost comparisons for a number of local ground distribution configurations for instructional television. Bernstein[7] has prepared a memorandum which spells out legal constraints on the use of telecommunications for distributing educational materials. In the area of organizational design, with which this memorandum is concerned, DuMolin and Morgan[8] have described one possible organizational framework for a school-oriented educational satellite system.

This memorandum is intended to lay some additional groundwork for later organizational design work by defining and analyzing several broad organizational issues. The text which follows this introductory section is divided into two main parts. Whereas Part B (Exploring Issues and Options at the Component Level) breaks the concept of a large scale educational telecommunications system into its separate components, Part A (Topics of System-Wide or Recurring Significance), focuses on issues which apply to the system as a whole rather than to any particular component. Part A also includes discussion of some

issues which arise for more than one component but which can be given adequate coverage in one round instead of being repeated for each component.

Besides facilitating resource sharing and greater productivity in the education sector, development of educational telecommunications could improve access to educational opportunity for those groups who are now educationally deprived. It should be recognized, however, that an educational telecommunications system will improve access for such groups only if it is methodically designed to do so. It could accomplish just the reverse, improving opportunities primarily for those who already have greatest access to educational services. Therefore, Part A begins with a discussion of the ingredients of access and how those ingredients might be manipulated to achieve predetermined goals.

Section 3 of Part A discusses some positive and negative implications of vertical integration; i.e., placing more than one phase of the telecommunications process under control of a single organization. Following this, some alternative modes of control (e.g., non-profit corporations, government agencies, profit-seeking corporations etc.) are explored. In spite of the seemingly endless train of unknowns and novel problems which beset the designer of an educational telecommunications system, it is useful to search past experiences for ideas. The discussion of general organizational alternatives takes this tack by examining the reasons why, in a fundamentally private enterprise system, various forms of public participation have been employed in past situations. An attempt is made to separate out those reasons which are applicable to an educational telecommunications system from those which are not. This analysis is not intended primarily as a discussion of public enterprise. Rather, it is intended to explore the "basic nature" of educational telecommunications to find out if there are any inherent reasons why development of an educational telecommunications system should not be left to private enterprise. The discussion then moves from the more general issue of private versus public enterprise to an analysis of how such varied organizational models as the Tennessee Valley Authority, Corporation for Public Broadcasting, Communications Satellite Corporation, etc., might be adapted for use in an educational telecommunications system.

Questions have been raised concerning the ownership and control of ground hardware. A separate section is devoted to these questions, with special emphasis on the issues involved in the question of leasing versus purchasing equipment. Finally, a discussion under the heading of "development strategies" has been included. Of primary concern in that discussion are public policies which might be employed to stimulate the participation of the private sector where such participation is deemed desirable.

The second main part of the memorandum moves a step closer to actually devising alternative systems by examining available options for each of the major components which make up a satellite-based educational delivery system. These components have been identified as Program Sources; Storage/Origination Points; Transmission (satellite and ground segments); and Local/Regional Distribution Systems. The discussion

includes remarks about problems unique to each component as well as an enumeration of some alternative organizational structures for each component.

The procedure followed in Part B is intended as a building block approach to devising "total system" frameworks. A number of alternatives exist for each component, and the possible combinations are many. When the task of presenting specific blueprints is undertaken in a subsequent memorandum, it will be possible to spell out only a few representative combinations. It is hoped the modular approach used in Part B of this memorandum will enable other analysts to form combinations in accordance with their own sets of criteria.

2. Pressures on the Education Sector for New Approaches

There are currently numerous financial and social pressures at work on the education sector which may help to bring about large scale utilization of telecommunications. Among these are demands for further equalization of educational opportunity, regardless of residence or financial status; for education more responsive to the needs and abilities of the individual learner, rather than the lock step, "take it or leave it" form of education that predominates today; for greater accountability and productivity; and for services to segments of the population heretofore not included as regular clients of the formal educational system: people requiring job retraining; people needing continuous updating of knowledge in their career specialties; people preparing for occupational advancement; people seeking education for personal enrichment (Adult Vocational and Continuing Education); preschool children (Early Childhood Education); people confined to hospitals and prisons or handicapped people (Special Education). Until very recent years, Early Childhood Education, Adult Vocational and Continuing Education, and Special Education have received scant attention in comparison to K-12 and higher education. As a group, these services and some of their delivery mechanisms have come to be known as "non-traditional education." In short, education is being asked to do much more without drastic increases in available financial resources. For a more complete definition of these needs and pressures, the reader is invited to consult reports by Morgan et. al[9] and Rothenberg.[10,11]

3. Opportunities With Educational Telecommunications

3.1 Rationale

From the Pressures just identified emerge some basic rationales for using technology in education, particularly telecommunications technology.

COST REDUCTIONS THROUGH RESOURCE SHARING -- Telcommunications can facilitate the sharing of educational resources and thereby reduce the diseconomies of unnecessary duplication.

EQUALIZING ACCESS -- Since the cost of satellite communications is independent of distance, satellites can give even the most remote users low-cost access to major resource centers.

MORE FLEXIBILITY AND RESPONSIVENESS TO INDIVIDUAL NEEDS -- Telecommunications can take education to the learner in his home, at his place of work or wherever else he may be.

LOW-COST DELIVERY FOR NON-TRADITIONAL SERVICES -- Since non-traditional forms of education are relatively new, the problem of being locked into teacher-centered, classroom instruction has not yet developed. Therefore, it may be in the non-traditional areas that telecommunications has the best chance to be tested on its own merits or shortcomings as a low-cost and effective mode of delivery.

3.2 Educational Telecommunications Service Categories

Educational telecommunications services fall into three general categories. Each category involves different channel requirements. The particular mix of services selected by users and system management will significantly affect the technical requirements and cost of the educational telecommunications system. These service categories are:

INFORMATION DISSEMINATION AND BROADCAST SERVICES -- One-way, point-to-multipoint distribution: Conventional radio and television broadcasting; Instructional Television Fixed Service (ITFS); Closed-circuit TV (CCTV); non-interactive cable television (CATV); Information Retrieval Television (IRTV), in which distribution is at the user's request but involves no interaction between viewer and source; Responsive television (RTV), involving interaction but only at the receiver end of the system; etc.

INTERACTIVE TELECOMMUNICATIONS SERVICES -- Teleconferencing; talk-back instructional television; on-line information retrieval from computer storage banks or libraries; computer-assisted instruction (CAI); remote time-sharing; etc. Requires two-way communications capability, with channel capacity requirements being mostly asymmetrical -- i.e., greater from source-to-user than from user-to-source.

COMPUTER COMMUNICATIONS SERVICES -- Remote batch processing; resource sharing; distributed intelligence and time-sharing. Channel capacity requirements high and frequently symmetrical in machine-to-machine applications.

3.3 Roles of Satellites

Not every educational telecommunications service will involve the use of satellites. The United States already has an elaborate telecommunications infrastructure, consisting of telephone lines, broadcasting, point-to-point and multipoint microwave and, more recently, cable. Satellites will have their greatest impact in providing services which

accent the unique features of satellite technology, handling tasks which the terrestrial system can't handle or providing existing services more efficiently. In the total mix of services, satellites have four primary roles to play:

a. Networking members of widely dispersed groups with common educational interests for distribution of materials from a central point or for teleconferencing over audio or video channels.

b. Delivering high quality educational materials to small and remote users and providing return link capability for addressing information resource centers or CAI centers.

c. Interconnecting state and local networks with regional or national computing and instructional resource centers, including linking broadcasting stations and CATV systems with program centers.

d. Interconnecting local, state and regional networks among themselves for resource sharing, including networking of public broadcasting stations for sub-national programming and feeds to program assembly centers; also including interconnection of libraries for interlibray loans and other sharing applications.

4. Previous Organizational Design Work

Very little has been done in the way of organizational design for large scale educational telecommunication systems. A review may help to place this memorandum in perspective.

EDUNET[12] -- In 1967, the Interuniversity Communications Council (EDUCOM) sponsored a summer study to develop the concept of a coast-to-coast interuniversity information network (EDUNET). A book reporting the results of the conference explores a vast array of possible services of a national information network and considers a large number of important organizational issues, including financing, management, copyright, available distribution channels, alternative network configurations, technical standardization requirements, etc. The study focused primarily on terrestrial modes of distribution and concentrated on the needs of universities, although a few other applications, such as health care and medical information networks, were also considered.

INTERLIBRARY COMMUNICATIONS -- A more recent publication in the area of organizational considerations for information networks resulted from the proceedings of the 1970 Conference on Interlibrary Communications and Information Networks.[13] Like the EDUNET report, it did not deal specifically with opportunities for using communications satellites. Nor did it propose any specific systems. Nevertheless, the broad spectrum of organizational issues considered and the large number of experts from government, industry and education who participated in the conference

and who contributed articles to the final report makes the publication of major significance.

HULT[14] -- A paper prepared by HULT explores opportunities for providing new television services, using satellites and CATV. A number of new regulatory and operational policies are suggested. One major idea proposed is separation of programming and transmission operations. An added feature would be a single earnings regulated common carrier responsible for operating all the CATV and broadcast TV facilities in any given area. A program distributor relaying programs to an area via satellite would negotiate with a single transmission carrier to deliver programs to the target audience. The carrier would select the most efficient transmission mode to accomplish delivery. Hult suggests that this framework would facilitate a graceful evolution of the division of transmission services between broadcast and cable facilities.

FORD FOUNDATION PROPOSAL[15] -- Proposals for organizational structures for educational communications satellites date back as far as 1966, when the Ford Foundation advocated establishing a Broadcasters' Non-Profit Satellite Service (BNS) to serve the interconnection requirements of both commercial and non-commercial broadcasters. Access for non-commercial broadcasters would have been free. Commercial broadcasters would have paid for satellite service, but at prices estimated to be considerably less than the cost of existing terrestrial interconnection. Part of the proceeds would have been used to finance programming for non-commercial broadcasters.

EDUSAT[16] -- During the summer of 1968, a multidisciplinary team of fifteen faculty participants developed EDUSAT, A Preliminary Design for an Educational Television System for the United States in the Mid-1970s. As the title implies, the study encompassed only television distribution. Three types of television service were envisioned: Public Television, Instructional (in-school) Television, and Special Television. Distribution would be from a single, four-channel satellite. During evening prime time hours, public television would have control of all channels, so that ETV stations could have a selection of as many as four different programs from the satellite system. One channel would be capable of delivering programming directly to homes and schools. It was recommended that a non-profit corporation, patterned after the Corporation for Public Broadcasting, be established to operate the system. Funding would be from a variety of public and private sources. However, it was strongly recommended that programming be financed strictly by private sources, in order to prevent government influence over content.

SHEPPARD PROPOSAL[17] -- The first educational satellite proposal encompassing computer-assisted instruction (CAI) as well as television was made by Sheppard in 1970. Sheppard's proposal called for dividing the nation into 15 educational regions, each containing from one to six states and having approximately equal numbers of students. Seven satellites in synchronous orbit would provide enough channel capacity so that each region would have at least one TV channel and enough data capacity to allow one CAI terminal for every 25 students, or 15 minutes of CAI time per student per day. Each region would have a major TV production

and computer facility. Sheppard estimated a cost of approximately $8.00 per student per year. He points out that if that figure is increased to $25 to account for software and maintenance, the figure is still reasonable if one compares it to a typical yearly per student expenditure of $500.* Sheppard's proposal is restricted to school-oriented services. No organizational framework other than the regional divisions was proposed. Although social and political factors were not discussed at length, Sheppard did point out the critical need for analysis in those areas.

WASHINGTON UNIVERSITY STUDIES -- A study performed by Ohlman[18] in connection with the Washington University satellite-education program contains a qualitative description of "A Satellite-Based Multipurpose Educational Service." Ohlman does not deal with such organizational issues as administrative or financial support structures. Instead he developes an exhaustive description of the types of technology and media that might be used in conjunction with an educational satellite.

Another Washington University study, performed by DuMolin and Morgan,[8] developes a proposal for "An Instructional Satellite System for the United States." This study contains what is probably at this time the only detailed description of an organizational framework for control and administration of a satellite-based educational delivery system. The AVSIN (Audio-Visual Satellite Instruction) plan calls for two independent spheres of control -- (1) the administrative segment, which would be a non-profit corporation to control the satellites, ground equipment and accounting system and (2) the program-production segment, in which software would be made available on a competitive basis. The purpose of the non-profit administrative segment is to insure adequate service to remote areas, where a profit-seeking operator might not find it practical to serve. By placing control of software in a separate competive segment and by making the satellite corporation function as a common carrier (i.e., providing access to any distributor who wants and can afford to market software through the system) it is expected that users would benefit from a diversity of software provided at the lowest possible prices. In the AVSIN system, which would be designed to serve schools, dial access to the system's resources is envisioned. At a school's request, material would be distributed to school recording terminals and replayed when requested by a teacher. Attention has also been given to other modes of distribution, such as real-time reception for instantaneous use in schools and viewing centers or distribution to ITFS and cable headends rather than directly to schools.

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* Actual per pupil expenditures are considerably higher than the $500 figure used by Sheppard. 1971-72 per pupil expenditures at the elementary and secondary levels averaged an estimated $874, based on average daily membership.[19]

THE GENERAL ELECTRIC/PBS STUDY[20] -- A study performed by Dysinger et. al at General Electric for the Public Broadcasting Service synthesized a large number of possible satellite system configurations to determine the lowest cost combinations of satellite and ground equipment to serve the operating requirements of public broadcasting. The optimal configuration that emerged was a high channel capacity system (up to 96 channels), giving 50 state coverage and capable of serving the requirements of public broadcasting for sub-national distribution and multiple origination points. Cost reductions would be realized through a two-service concept involving one grade of reception for low-cost receivers at schools and another grade of service to networking terminals at TV stations. This concept allows reception at the point of use, minimizing the need for redistribution through terrestrial systems. The study also indicated that the system could easily be expanded to satisfy the needs of commercial TV networks. Sharing between commercial networks and educational users would be possible due to the fact that peak use for networks would be during weekday evenings and on weekends, while peak use for educational users would be during Monday through Friday, day-time hours.

Although the works cited above are important contributions to the study of educational telecommunications planning, more work remains to be done. It is intended that this memorandum add to those previous efforts in several ways. First and foremost, the memorandum focusses on organizational and administrative aspects, rather than on technical considerations or specific potential services. Second, it assumes a system of national scope and a heavy commitment to the use of fixed/broadcast satellites in the telecommunications mix. Third, its perspective covers the whole range of potential educational applications rather than a single market, such as public television, schools or libraries. Combining these features in a single effort is considered essential to the systems synthesis phase of the Washington University satellite-education program.

PART A

TOPICS OF SYSTEM-WIDE OR RECURRING SIGNIFICANCE

1. Introduction

Whatever organizational plan is eventually implemented, a satellite-based educational delivery system will be a configuration of four basic components, as shown in Figure 1.

1. PROGRAM SOURCES

   a. Producers and Distributors

   b. Storage and Origination Points -- locations where software is collected, processed and loaded into the transmission system. In most systems, the storage component would also involve "holding" points between the receiving end of the transmission system and the ultimate user; for example, a school closed circuit or cable television headend.

2. TRANSMISSION

   a. Satellite segment

   b. Earth terminals (receive only and receive/transmit)

3. LOCAL/REGIONAL DISTRIBUTION -- communication links between satellite earth receiving terminals and final delivery points or between program storage/origination points and ground-to-satellite (uplink) transmitting stations.

4. USERS -- The term "user" is employed frequently in this report to connote one or more individual learners; households; institutions where learners go to participate in the educational system (e.g., schools, libraries, community centers); Organizations formed to coordinate system utilization by constituent groups and institutions (e.g., Federation of Rocky Mountain States). The term "users", "audiences," and "consumers" are employed interchangeably. Although software distributors might also be considered "users," they will be identified separately in this memorandum.

Throughout the process of drawing the major components together into

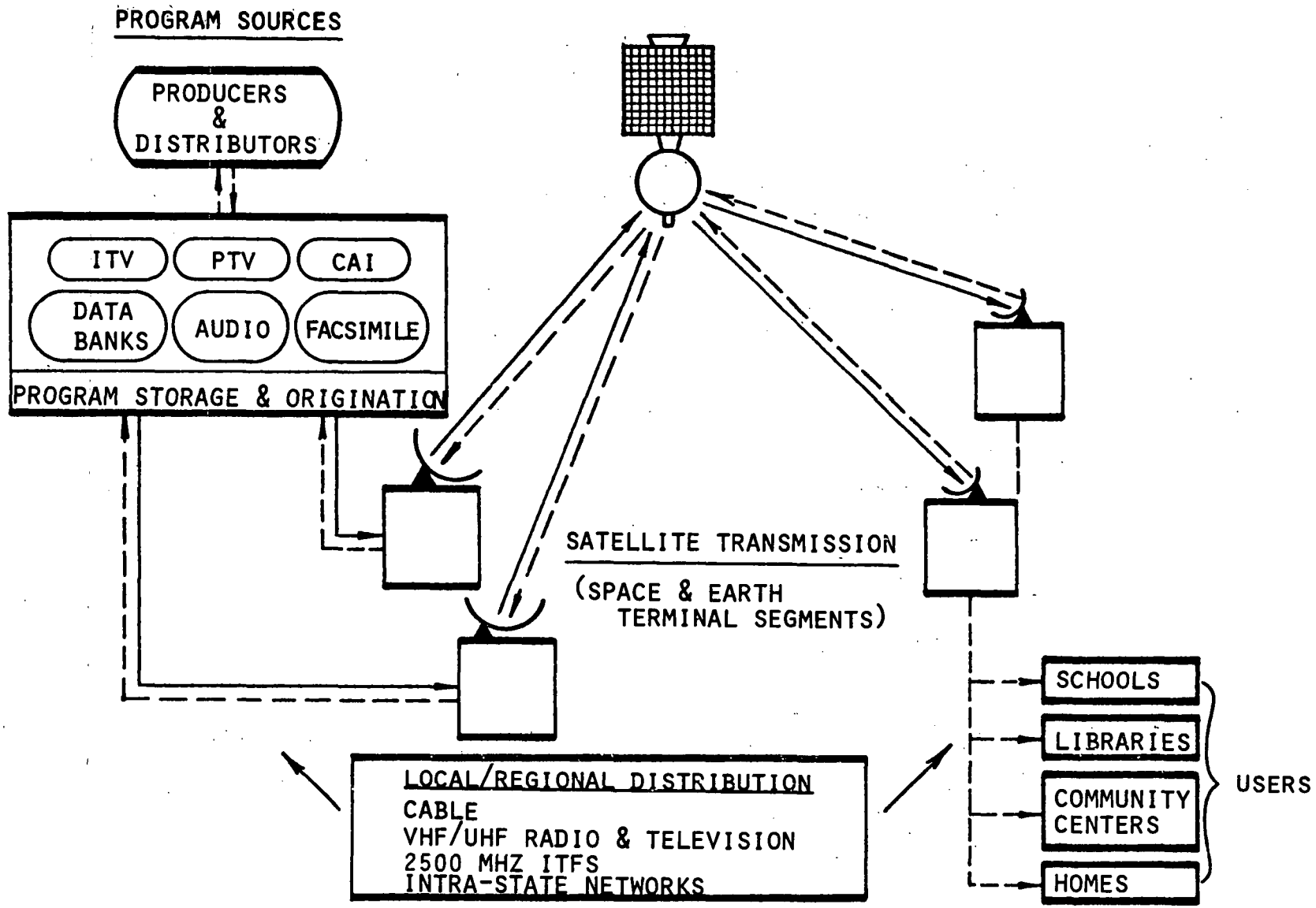

FIGURE 1
EDUCATIONAL SATELLITE SYSTEM COMPONENTS

a workable system, the designer is seeking answers to three general questions:

1. WHAT INFORMATION IS GOING TO BE DISTRIBUTED BY THE SYSTEM -- who produces the information; who chooses the information to be distributed; and on what basis is that choice made?

2. HOW IS THE INFORMATION TO BE DELIVERED -- what distribution systems are employed; and how, and by whom are those systems controlled?

3. TO WHERE AND WHOM IS THE INFORMATION TO BE DELIVERED -- who benefits from the services; who chooses the beneficiaries, and on what basis; where do people receive the services, and who controls the consumption points?

These general questions underlie the several areas of concern discussed below, all of which are involved in developing alternatives for any one of the major components.

2. Access

2.1 Introduction

The issue of access is highly sensitive and of crucial significance. System design will affect the accessibility of services; and the accessibility that is structured into the system, in turn, will be decisive in whether or not the system is socially, economically and politically acceptable, as well as educationally sound. The access issue must be viewed from the perspective of both the producer/distributor -- who is concerned with whether he is able to distribute his goods via the satellite-system -- and from the perspective of the user -- who is concerned with whether he can conveniently and economically utilize the services provided by the system. Access may be considered a function of proximity, ability to pay, consent and control.

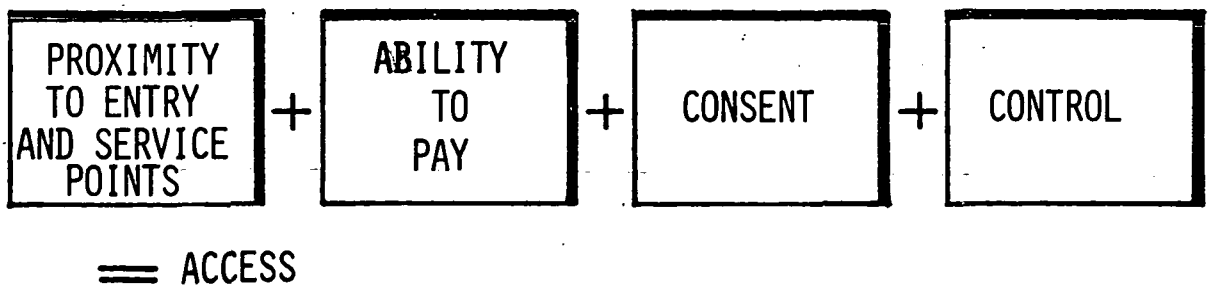

FIGURE 2
INGREDIENTS OF ACCESS

2.2 Proximity -- The placement of storage/origination points and consumption points --

Ideally, perhaps, every home would be both an origination and consumption point. Every household would be equipped with terminals that would enable its members to receive every service, from any place, in any form, at any time. Similarly every household would be able to feed facsimile, audio or full-motion video into the system for delivery to any other household. It would be the ultimate in the "wired nation" concept. Realistically, for the time being, this degree of accessibility is not to be had. However, when complete, the systems synthesis results should give a more precise evaluation of just what is or is not realistic. The expenditures of money, frequency spectrum space and orbital slots required for a system such as that described above are probably beyond our capacity to provide.* At the other extreme -- providing a single storage/origination headend and only a few consumption points would decrease accessibility for both potential distributors and users, to the point of making the system almost useless.

What must be done, of course, is to decide how to distribute available resources in a way that will maximize the system's utility. The suggestion made by Sheppard involves dividing the country into fifteen educational regions of approximately equal population.[17] Each region would be equipped wtih a central storage/origination headend and one computer-aided instruction (CAI) terminal for every 25 students. The problem with this approach is that in some parts of the country 25 students are more widely dispersed than in other parts. The upshot of this is that, in sparsely populated rural areas, people would have to travel greater distances to reach a CAI terminal than would people in densely populated areas. Truly equalizing users' physical access to CAI services would require decreasing the student-to-terminal ratio as population becomes more sparsely distributed. Before it becomes public policy to accomplish a one-for-one equalization of CAI or any other educational service, however, an assessment of whether a particular educational technology mix is as effective for rural inhabitants as it might be for various segments of the urban population is needed.

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* It should be pointed out that, while transmission costs and limited channel capacity may preclude such access on a national scale, local approximations (wired cities) may be possible, as evidenced by MITRE Corporation's experiments with Time-shared Interactive, Computer-Controlled Information Television (TICCIT). MITRE will soon test a large scale interactive television system in Reston, Virginia. 3500 Cable TV subscribers will have access on demand to a wide array of individualized services.[21]

2.3 Ability to Pay: Some Alternatives for Financing

2.3.1 The Pricing Mechanism

Scarce goods and services usually have a price. Increasing or decreasing the price of a service has the purpose of bringing demand in line with supply. In effect, a price decreases accessibility by placing a financial barrier between a service and a potential consumer. To many theorists, the pricing mechanism is the ideal, indeed the only rational way of allocating resources. In a price-directed market, the reasoning goes, resources will automatically flow to the place where they will provide the greatest utility, measured by willingness to pay.

But our's has never been an exclusively price-directed economy. We have always recognized certain services which hold out the potential of great benefit to society but which, if left to the marketplace, would not achieve a level of investment commensurate with society's collective need for them. Education has been one of these. By making basic education compulsory for people below a certain age, and by financing elementary and secondary education with public funds, this service has been made accessible to virtually everyone, albeit, at varying levels of quality. If parents had to pay tuition to send their children to school, in the absence of compulsory attendance laws demand would possibly decrease; although it is difficult to foretell just how large that decrease would be.

The argument can be made that "free" education distorts the market by creating an artificial demand for the service. Possibly, if parents were given the money the public sector now spends to provide education for their children, they would choose to provide education at home or in non-public schools. The result of such a "voucher" system would be smaller expenditures for public education.[22]

A thorough analysis of educational "vouchers" is not within the scope of this memorandum. But the dilemma which "vouchers" may help to solve - (i.e., between the problems with free public education and the problems with totally marketplace education) - has a parallel in educational telecommunications. If an educational satellite service were to be operated on a purely price-directed basis, there would be the risk of locking out users whose needs are great but whose abilities to pay are small. On the other hand, if educational satellite services were to be offered "free," there would be the risk of overloading the system with users who, if required to pay prices reflecting the cost of services, would seek other means of obtaining or delivering educational services.

One way of resolving the dilemma would be to keep the pricing mechanism intact and provide needy users or distributors with direct educational subsidies, i.e., subsidies paid directly to the user, to

be spent to deliver or obtain services by the most efficient* available means, whether that be by satellite or bicycling around videocassettes. The effect would not necessarily be to decrease public expenditures for delivery of educational services, but to keep off the satellite system traffic which could be carried by more cost-effective means. This would enable the planned capacity of the system to be reduced, thus lowering the total cost of the system, although not necessarily the per user cost. Indeed, high fixed costs for the distribution plant make lower unit costs achievable by expanding capacity and traffic volume.[23]

It has been noted that direct subsidies would enable users to have the necessary purchasing power to use satellite-delivered services at cost without preventing the user from obtaining educational materials by some more efficient means or in some more desirable form. If one of the system's objectives is to make its services accessible to all who can benefit while, at the same time, screening out inefficient users or distributors, then the direct subsidy approach appears to have merit.

Another potential advantage to "voucher" schemes, which is what direct subsidies amount to, is that they might have a tendency to force integration of subsidized and unsubsidized users in the educational market. The concern has been expressed that a two-track educational system might evolve, in which less affluent educational consumers would come to rely on telecommunications-based delivery for educational services, while more affluent consumers would continue to receive educational services in face-to-face settings when preferable to telecommunications-based services. This has been the experience with public housing. Subsidized renters have been forced into highrise ghettos; whereas, if they had been given "vouchers," they may have located in neighborhoods inhabited by unsubsidized consumers.[24] "Vouchers," enabling the subsidized consumer to choose either telecommunications-based services or, when more suitable, some other mode might have a tendency to prevent the two-track system from evolving.

If, however, over-use of the system is no problem, and public policy is to maximize the volume of traffic in order to hold down the per unit cost of the system, then restricted subsidies (i.e., money which can only be spent for obtaining materials through the satellite component of an educational delivery system) might be the way to go. This method might be a roundabout procedure if the system is to be owned and operated by a government agency. At first glance, it would appear

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* The term "efficient" is used several times in this memorandum to describe the situation in which a given educational requirement is being met at the lowest possible cost, regardless of whether the service is paid for by the user or subsidized. Thus, it is possible for a user to deliver or obtain educational service free through a subsidized delivery system, even though that system is not the most efficient available means.

that there would be little sense in paying out subsidies, only to have them returned in total as payment for services. On the other hand, by paying out subsidies, the government or some other agency would be able to be discriminatory and to target funds on those it most wants to use the system and to avoid subsidizing customers who would use the system even without subsidies -- something which could not be accomplished in a taxpayer-supported, no fee service.

2.3.2 The Problem of Inelasticity

Should reliance on the price mechanism, either standing alone or modified by some form of subsidy, be the chosen policy, there are additional items of considerable importance. To some students of economics, a price which is significantly above the cost of providing a good or service is a symptom that the price mechanism is not working. One circumstance which can lead to abnormal revenue margins is explained by the concept of price elasticity of demand. Briefly, a service is said to be price elastic if a change in price brings about an at least proportionate inverse change in demand. If demand is not so responsive to change in price, the good or service is said to be price inelastic.[25]

It is conceivable that, in the long run, demand for access to a satellite-based educational delivery system could grow larger than system capacity. Whether or not such a shortage is likely depends on many factors, including acceptance of educational networking services, the types and patterns of educational communications traffic, system configuration and frequencies cleared for educational use. If demand did outgrow capacity, price inelasticity would mean that it would be difficult to bring demand in line with supply through price adjustments alone. Prices could be adjusted upward without appreciably decreasing demand, so long as the prices were lower than the cost of using a substitute service, or so long as the prospect of going without service altogether would be a less attractive alternative.

An example of price inelasticity at work in the communications industry can be seen in the telephone business where local exchange rates have increased by more than 40 per cent since 1940 while demand has continued upward. On the other hand, tolls for services where substitutes exist, and demand is therefore more price elastic, such as interstate private-line microwave service, have generally declined since 1940.[26]

Whether price inelasticity might exist in an educational telecommunications system is difficult to predict. The degree to which we become dependent on the system because of its displacement of other delivery means would be a major determining factor. If price inelasticity did intrude, it could mean that prices would have to be set considerably above the cost of providing the service before demand would thin out. In the case of a private commercial operator, the excess revenue would contribute to higher dividends. In the case of a government agency operator, the excess revenues might go to general treasury coffers. This would amount to a transfer of financial resources from the education

sector to other public sectors. A non-profit corporation might be able to utilize the excess revenues to expand capacity. But if spectrum space limitations preclude expansion, users or distributors would continue paying prices higher than the cost of the services provided to them.

2.3.3 The Effect of Misallocating Costs

The problem of the ineffectiveness of pricing as an allocation mechanism can be exacerbated if users or suppliers do not pay the entire cost of the services provided them. The air transporation industry provides a useful example. The landing fees paid by airlines and other aviation traffic cover less than half the costs of providing runways and terminals. The remaining costs are covered by terminal concessionaire fees and government subsidies. The size of the landing fee, based on aircraft weight, has not always been related to cost. Thus there has been little incentive to make efficient use of runways or to schedule flights for non-peak load periods. If efficiency incentives did exist, there might be less congestion in the nation's airports. Raising landing fees, while retaining the present level of subsidies, would result in revenues greater than the actual cost of providing runway services. It has been suggested that the best policy would be to decrease subsidies and to make airlines responsible for paying a greater share of the landing costs, thus increasing their efficiency incentive, but not increasing total revenue.[27]

This example is used to illustrate what might happen if satellite delivery or retrieval is made artificially cost attractive by allocating to users only part of the actual cost of the service.

2.3.4 Fee Structure and Accountability

Another aspect of the subsidy question has to do with distributor accountability. If instructional materials are offered "free" to users, with the tab being picked up by the taxpayers or an independent benefactor, there is the possibility that the distributor will be in the business of pleasing the funding agent and not the users. "He who pays the piper calls the tune." But if the bill is picked up by those who use the system -- schools, business training centers, individuals in community learning centers, etc. -- the distributor is more likely to respond to the expressed desires of those users.[28] The argument for user supported services has been set forth by proponents of pay-television.[29] Advertiser-supported television, the argument goes, serves the interest of program sponsors, which is to draw the largest possible audience. The only measurement is total audience size. There is no way to measure the intensity of value the "free" program holds for its viewers. With pay-TV, a minority audience can express its desire for a particular program by the amount it is willing to pay for the program. One million viewers would not be able to entice an advertiser to sponsor a network program. But, in a pay-TV system, if those one million viewers are willing to pay $1.00 each to view a program, the program would stand a better chance of being made available. The import of this for our purposes is that, if users, rather than a third

party, pay for services, they are likely to have a larger voice in what is made available to them.

A related question concerns just what form payment should take. This is something which would have to vary according to the nature of the service. Some services, such as those which might be delivered to the handicapped, might be financed by government and offered at no charge to users. Satellite-delivered services relayed to homes via cable could be paid for from the regular monthly subscription fee paid for basic cable service, from a flat rate charged only to those customers subscribing to a special supplemental channel service, or from charges made for each unit of programming viewed. The latter, a pay-TV arrangement, gives the most sovereignty to individual customers, since it allows the customer to pay only for those services used and forces the software sources to offer services which are appealing enough to draw customers on their own merits, rather than as part of a package. On the other hand, the arrangement involves extra costs resulting from installation of special equipment to prevent non-payers from tuning in.

Schools have paid for instructional television programming on both a flat rate and individual program basis. In the case of ITV tapes circulated through the mail by the national ITV libraries (see section 2.5 of Part B), schools pay on a per program basis. Since programs have to be ordered and mailed to the schools, it is a very practical matter to confine use to paying customers. Should these libraries be hooked into a direct satellite distribution system, to insure payment would require other means similar to the automated billing system used by the telephone company or remote control of receivers by the system operator, as suggested by DuMolin.[8]

When the Midwest Program for Airborne Television Instruction (MPATI) was operational, there was no way to prevent non-paying schools from tuning in on programs broadcast from an aircraft circling at 23,000 feet. The "free-loading" may have prevented MPATI from becoming financially self-sufficient.[30] School systems who contract with educational television stations to broadcast programs provide yet another model. In some cases, home viewers can be motivated to pay for programs by requiring payment of an enrollment fee from those who desire course credit or supplemental printed materials.

2.3.5 Conclusions

As has been indicated in foregoing paragraphs, policy architects have many issues to resolve just with regard to pricing and subsidizing the use of a satellite-based educational network. In weighing various options, the following thoughts seem worth emphasizing:

1. If it is deemed desirable to provide access strictly on the basis of ability to pay, then the price mechanism can be relied upon to allocate the benefits of an educational telecommunications system. However, this would not take into account potential users who would find services extremely valuable but who lack the financial ability to express that value in the marketplace.

2. If it becomes policy to make the system accessible on the basis of ability to benefit from services, rather than on the basis of ability to pay for them, the price mechanism will need to be supplemented by some form of consumer subsidization. It may be equally important to subsidize the suppliers and distributors of software in order to insure that enough high quality software is made available, so that consumers find the system worth having access to.

3. To the extent that excessive demand for channels is a problem, and pricing is chosen as one means of thinning traffic, decision makers should determine just how sensitive demand is to changes in price. If demand is insensitive to price changes, "price allocation" may be another way of saying "selling to the highest bidder," with prices for services being set at levels much greater than the cost of providing the service.

4. If under-utilization, rather than excessive demand, is the problem, demand stimulants in the form of financial aid restricted to use of satellites or below-cost pricing would be appropriate.

5. If the user pays directly for services, the system is likely to be responsive to his needs. If the user can pick and choose services individually, rather than paying a flat rate for a package of services, the system will likely be even more responsive to his needs. The extra benefits of per unit payment should be weighed against the extra costs of providing special equipment to keep track of use on a per unit basis.

2.4 Consent: Allocating Access by Fiat

Manipulating the financial support structure is only one way of stimulating or restricting the traffic load on the system which has been discussed. Another way was suggested in the discussion of placement of services (proximity). If people are not located near a point where they can either feed into the system or extract from it, they are in effect prevented from contributing to any traffic problem.

Use of the system can also be apportioned by fiat. This approach can manifest itself in several forms, all of which require that the user obtain permission to use the system, regardless of ability to pay or proximity to entry and retrieval points.

2.4.1 Apportionment of Access by Time of Day

One suggestion that has been made would involve apportioning use of available channels by setting aside certain parts of the day for certain categories of users. For example, 6-8 a.m would be reserved for Adult ITV; 8 a.m - noon for live in-school ITV etc.[18]

Conceivably this could be a one-way, operator scheduled system, with users selecting from what is offered at the discretion of the system operator. Or it could be a demand-access system in which users could address the system on a first come basis during the "day parts" apportioned to them.

A question has to be raised as to whether this approach would really accomplish the purpose stated here or whether it would merely decrease the accessibility of the system. Not only might users in a catetory be prevented from receiving services at times better suited to their individual needs, but the accumulation of all consumers in a given category during a specified time period might create a traffic jam worse than what would occur if all cateogries could use the system at any time, thus spreading out each category through the whole day. The apportioned "day-part" approach would appear to be most suitable if the intent is to have a centrally controlled and programmed, one-way system. In such a system traffic volume would not be the concern. Assignment of "day parts" to specific user categories would be a scheduling technique rather than a way of controlling traffic volume. Many users would probably record materials for later use.

2.4.2 Apportionment of Access by Priority

In a system in which there is a significant discrepancy between demand and capacity, it may be desirable to develop affirmative policies on access, as an alternative to the more passive policies of price allocation and first come, first serve. First, ability to pay would not, in this writer's opinion, be acceptable as an exclusive method of user selection and exclusion. Secondly, if the system can only be used to serve a portion of the potential users, then steps possibly should be taken to insure that the limited capacity is used to serve whatever educational priorities may be set. Whether any person or group of persons has the wisdom to make such decisions is a question that can be debated endlessly, without a definitive answer ever emerging. There is a danger that, even if educational priorities could be accurately determined in the first place, there might be a time lag between changes in real educational needs and changes in the organization's established priorities. Nevertheless, the alternative is there. At some point in time, it was decided that the public interest would be best served by giving radio and TV station licensees the responsibility to make judgements about the content to flow through the channels they control. That decision has been questioned in recent years. Proposals have been made for a "statutory right of paid access" to the airwaves,[31] which would, in effect, give broadcasters some characteristics of a common carrier.

Part of the question of whether human judgement would really result in more rational utilization than in a purely price-directed or first come, first serve system rests with the concern that the power to decide who does or does not gain access could be abused. Government or corporate favoritism, or just plain ineptitude could occur.

2.4.3 Obtaining Consent in Non-Dedicated Systems*

In a dedicated terrestrial or satellite network where information carrying capacity might be inadequate for demand, the issue of how to effectively and equitably allocate services among educational users would be perplexing enough. The problem would obviously be aggravated if users had to contend not only with other educational users but also with non-educational users. The technical problems of riding "piggyback" on a satellite system developed for non-educational users have been discussed in Part B, Section 4.1 of this memorandum and in other publications.[4] The fundamental concern is that, although such non-dedicated satellites may well provide the necessary channel capacity, the capabilities of these satellites are not likely to fit the unique requirements of educational networking. Thus an abundance of channels on non-dedicated satellites may be almost useless to educators. Assuming for the moment that a dedicated satellite segment is deployed, there remains a need for access to ground distribution channels. It would be ironic if we were to deploy a large capacity, dedicated satellite segment only to have most of its channels lie fallow because of a distribution bottleneck on the ground. Such a bottleneck would be most likely in a telecommunications system based on dedicated satellite and non-dedicated ground components.[32]

A study by Barnett and Denzau[5,6] has indicated that a 40-channel CATV system dedicated to educational uses would be more economical than a 4-channel ITFS system in certain communities where school populution is closely clustered. But for reasons to be discussed in the second part of this memorandum, (section 5.2) there may be serious problems in bringing about widespread implementation of dedicated CATV systems.

Under rules which became effective March 31, 1972 CATV systems in major markets are required to have 20-channel capacity and capability for narrow-band return communications. The rules require major market cable operators to make available at no charge at least three access channels -- one a public access channel available on a first come, non-discriminatory basis; another for local government use; another designated for use by local educational authorities. Any unused channels are to be offered on a preemptible basis for leased access services. The rules are effective for cable systems which commence operations after March 31, 1972. Systems established prior to that date have until 1977 to comply with the rules.[33] The requirements are in partial accord with National Education Association recommendations that

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* Non-dedicated systems are those not reserved for use by any particular category of users, such as educational users.

20 per cent of cable channel capacity be reserved for access services.[34]

But one channel reserved for education is hardly adequate when the opportunities of a fully matured educational telecommunications system are considered. How is use of the free education channel to be determinned -- by the local board of education, or by some other agency set up to administer use of the channel? The rules only say "local education authorities." Will the channels be utilized for an open university system, for delivery of services to classrooms, for storage headend-to-home dial access service or for some other educational use? Assuming dedicated satellites and largely non-dedicated terrestrial systems, the apportionment of scarce capacity among educational users is potentially a much more serious problem on the ground than in the sky, because of the relatively small number of cable channels reserved for educational purposes.

A recent report by the National Cable Television Association indicates that educators have been unwilling or unable to utilize even the limited cable channel capacity made available to them.[35] But one would expect the situation to reverse itself as awareness of cable is heightened among educators, if financial and organizational support develops.

It may be possible that some of the time on a cable channel reserved for education could be allocated to specific regular uses, while the remaining time would be made available on a first come basis. At the same time, educational users would be free to lease some of the leased access channels. Even a dedicated system could be organized with some channels reserved for specific users and the remaining channels made available on a first come basis.

Mixed systems incorporating both controlled and common carrier access would enable decision makers to assure access for specified high priority users. At the same time there would be a diminished risk of some users being totally locked out because of arbitrarily determined priorities.

2.4.4 Copyright: Obtaining Consent for Use of Software

2.4.4.1 Introduction

Access to the services of an educational telecommunications system requires consent not only from those who control the information channels, but also from those who have certain rights to restrict use of the information which could be distributed through the channels. Such rights exist by virtue of the copyright statutes.

Few would quarrel with the basic notion that one who invests time, energy and money to develop and publish a work should be entitled to reap some monetary reward when others benefit by the use of that work. Nor would many dispute that such reward is necessary as an incentive for the author to keep producing.

But there is considerable debate over the type and extent of protection that should be permitted. According to Bernstein,[7] the requirement that an educational telecommunications system obtain the consent of copyright owners prior to using copyrighted materials imposes three major constraints on the operation of the system. First, consent usually requires payment of a fee, which increases the operating costs of the system. Second, in order to obtain consent, the user must first find the copyright owner. Since an author can and does assign his rights to a publisher or some other representative, finding the agent with authority to grant consent can be expensive, time-consuming and highly frustrating to the user whose need cannot wait for such administrative operations. Third, in many cases the copyright owner is not obligated to give consent at any price.

2.4.4.2 Public Domain Policy

At this point, it should be noted that a U.S. Office of Education policy announced in 1970[36] may alleviate the problem somewhat. According to the policy, an organization or individual who develops materials with U.S.O.E. funding is entitled to publish but not copyright those works. Competing publishers may market and copyright their own versions, as may the U.S.O.E. contractor. But the original version is public domain.* The intent is to encourage price and product competition among publishers and to promote wide dissemination of materials.

The policy allows for exceptions in cases where it can be demonstrated that copyright is necessary to protect the integrity of materials during development or "as an incentive to promote the effective dissemination of such materials." In such cases, protection is to be authorized for less than the statutory copyright period of 28 years, which may be renewed for an additional 28 years. Ordinarily, five years would be the maximum period of protection which U.S.O.E. would authorize. When exceptions to the public domain policy are made, royalties go to the Office for transmittal to the U.S. Treasury. The intent of the exception is not to bolster profits, but to encourage dissemination by protecting the producer from the risk of ruinous competition, especially in cases where the market is considered to be "thin."

One can only conjecture as to the significance the Office's public domain policy would have for a large scale delivery system. The policy might benefit an educational telecommunications system in at least two ways. First, the system operators or user cooperatives might be able to produce their own versions of prototypes developed by U.S.O.E. contractors.

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* To prevent the contractor from using participation in development as a head start on competitors, Sec. 3(c) of the policy states that the contractor may not publish a copyrighted version until at least one year after publication of the uncopyrighted version.

Second, the policy would considerably diminish the chances of a software package being totally withheld from the market or from a particular user. However, it may also be the case that media software such as films would be less susceptible to modification for competing versions than printed materials are. The potential impact of the public domain policy on an educational telecommunications system is uncertain also because it is not known to what extent software will be developed with government support.

Most experts agree that the existing copyright law, enacted in 1909, is inadequate for dealing with situations which will arise as the result of new information processing technologies. For a discussion of copyright and other legal problems relating to educational communications systems, the reader is directed to a report by Bernstein.[7] Generally, the copyright issues center around three problem areas. First is the question of what educational uses of copyrighted materials should be allowed without consent. Second, what activity at the input and storage end of a communications system can take place without copyright infringement? Finally, how can a system be devised to efficiently monitor use of copyrighted materials, to secure clearances for use, to bill and to collect payments.

2.4.4.3 Educational Exemptions

With respect to allowable educational uses, the copyright revision bill now pending in congress specifies some educational applications which are exempted from the obligation to obtain consent of copyright owners. Suffice it to say that the exemptions relate to uses in traditional teacher-based, classroom instruction. Performance and display of copyrighted materials by means of an educational telecommunications system would be allowed only if the transmission were primarily for reception in classrooms or for people too disabled for classroom attendance. These exemptions would seem to preclude copyright immunity for such non-traditional services as home-based learning in an "open university" or student-initiated transmissions in individual dial-access retrieval situations, where a teacher need not be present.

2.4.4.4 Copyright Protection Against Unauthorized Input

Inherent in the concept of a large-scale educational delivery system is the gathering of software resources at large centers where the resources can be stored on tape, film, computer memory banks, etc. and, when the need arises, loaded into the system for transfer to dissemination points. Does storage constitute a use requiring consent and payment?

Publishers argue that copyright protection is required at the input end of the system because of the difficulty of maintaining any control over who uses the resources once they have been taken into the system. In other words, it's protection at the input end or no protection at all.[37] But, as Bernstein[7] has noted, much of the information stored might be used very little, while other materials would be used frequently. At the time of acquisition and storage by the system operator, there is no way of anticipating usage, so that assessing a fair price would be virtually impossible.

A concise summation of the importance of devising a workable system for monitoring, consent, billing and payment has been stated as follows:

> In addition to the financial burden of paying royalties, education may also suffer from the time involved in obtaining copyright clearances. Educational broadcasting has an interest in maintaining ready access to copyrighted materials. The delays necessarily inherent in seeking clearances for materials which would make an interesting and topical program simply cannot be tolerated in the educational process. The history of copyright clearance procedures is cluttered with long waits, red tape, and endless communications. . . At present, an educational station cannot finance the clerical staff necessary to secure copyright clearance on such a basis.[38]

If one substitutes "educational telecommunications system" for "educational broadcasting," the above statement is applicable to the whole gamut of services that could make up a satellite-based delivery system.

2.4.4.5 Solutions

Possible solutions have been suggested. While the question of what educational uses should be immune from copyright liability is subject to endless debate, any notion that education should be set off as a separate sector with no responsibility for paying for products it uses is clearly unrealistic. There are simply too many instances where the education sector constitutes the major portion of a producer's market. If compensation does not come from the education sector it doesn't come.[39] Also, it is the opinion of the author that the definitions of "education" and "educators" are becoming increasingly difficult to delimit. So it would be a frustrating chore to decide which individuals or organizations would be eligible for educational exemptions.

Marke[40] has speculated that one or a few "copies" of a piece of software will serve an entire network, so that the market for traditional mass publication of authors' works will be very limited. Because of this, Marke observes, the traditional method of using royalties on sales of books and other materials to provide compensation is unworkable. He predicts that new avenues of compensation will take the form of either outright sale of products to the system operator or a more complicated accounting system based on use instead of copies sold.

This is similar to the plan recommended in the hypothetical AVSIN (Audio-Visual Satellite Instruction) organization developed by DuMolin and Morgan.[8] In the AVSIN plan, each individual use of a software product would be automatically recorded by a computer. The user's account would be charged and the supplier's account credited. Precise monitoring and accounting is made possible by providing reception equipment on a lease basis and making the equipment operable only from the transmission end of the system, thereby preventing unauthorized use.

Leib[37] has raised the possibility of a "variable pricing" system (illustrated in Table 1) in which goods would be marketed at one price to traditional, individual copy users and at another price for "systems." This is an alternative to a method which would involve (1) determining the total revenue necessary to cover costs and a reasonable return, (2) calculating the total number of users (both system and individual users) who will buy the product after the introduction of a large-scale delivery system, and (3) dividing necessary revenue by total users to determine per user price. Under Lieb's idea, the first and second steps would still apply, but systems would be charged more than traditional users, because the product would benefit more people and therefore hold more value for the system user.

A combination of compulsory licensing and centralized system for obtaining clearances, patterned after the music industry approach, might provide a workable system. Under this approach, recording artists contract with either ASCAP or BMI which, in turn, grant blanket licenses to radio and TV stations, authorizing the stations to play most of the music recorded by artists under contract.[41] Stations pay an annual fee, a percentage of revenues, to ASCAP and BMI. Stations are periodically required to keep logs of the music they play. From these logs, the licensing agencies take samples to determine which works and artists are in greatest use and divvy up the licensing fee revenues accordingly. Whether a form of the music industry approach could be best applied to educational telecommunications through private organizations like BMI or by a special public agency would require further analysis. But the basic concept of centralized clearances appears to have merit. The compulsory licensing aspect of this concept developed from a 1950 consent decree, in which ASCAP agreed not to withhold a license from any user. If ASCAP and a user could not agree on a reasonable fee, the court would settle the matter.[42] Similarly, compulsory licensing procedures for an educational telecommunications system would give the user and the system operator guaranteed access to materials.

Is it possible that the guarantee provided by compulsory licensing would be required for an educational telecommunications system? There seem to be two primary justifications for answering the question in the affirmative. First, compulsory licensing would prevent a producer from charging what the market will bear for consent to use his works. Second, there is a possibility that software producers may perceive it to be in their economic interest to withhold their products from the educational telecommunications system altogether in order to protect the individual copy mass circulation market. For example, collecting royalties from the sale of individual videocassettes to thousands of customers may be more profitable than selling only a few copies to the telecommunications system and thereby eliminating the need for individual purchases. One would have to do considerable reading of software producers' minds to know whether or not this could prove to be a serious problem.

TABLE 1

HYPOTHETICAL ILLUSTRATION OF PRICE STRUCTURE BEFORE AND AFTER INTRODUCTION OF LARGE SCALE TELECOMMUNICATIONS SYSTEM AND LEIB'S "VARIABLE PRICING" SYSTEM*

Before Telecommunications System

Revenue needed to recover costs and fair profit for Program X		$7500.00
Pre-system demand projected for Program X: 2500 copies		
Pre-system price required:	$7500 / 2500	3.00

After Introduction of Telecommunications System

Post-system demand projected for Program X:		
System Customers	5 copies	
Individual Copy Customers .	745 copies	
Total revenue from individual customers:	745 x $3	2235.00
Total revenue needed from system users:	$7500 + 2235 = 5265	5265.00
Price per system user:	$5265/5	1053.00
TOTAL REVENUE		
From Individuals	$3 x 745	2235.00
From Systems Users	$1053 x 5	5265.00
		$7500.00

* This table was developed by the author of this memorandum for illustrative purposes. It does not necessarily represent Charles Leib's notions about the appropriate allocation of costs among users.

2.5 Control

2.5.1 Control Over Time of Use

From the user's vantage point, the quality of access to educational materials can be critically influenced by the degree of control that can be exerted over the time of use. Instantaneous demand access capability obviously gives the user much more control than does a system in which distribution of educational services is scheduled once only, at the convenience of the system operator. The absence of control inherent in operator-scheduled distribution can be tempered if distribution of a given service is repeated at various times, or if the user has recording or storage capability.

The consequences of operator-scheduled distribution can be decisive in the success or failure of a system. The history of ITV utilization should tell us something about that. There are several reasons why ITV utilization has been limited to an estimated 3 per cent of classroom time spent in elementary and secondary schools.[43] One of those has been the inability of teachers to have access to ITV programs when they wanted it. In schools which do not have their own TV facilities (at least a video record/playback machine) distribution control is in the hands of an ETV station or, in some cases, an Instructional Television Fixed Service (ITFS) headend. If scheduling by these origination points does not match with the needs of the user, the user (whether a teacher or home based student) has two choices: (1) schedule all other activity around the ITV program or (2) don't use the ITV service. Studies have demonstrated that many teachers choose the latter course and that the lack of control over scheduling is a major factor in determining whether or not to utilize ITV.[44] If the headend is organized to schedule distribution according to users' requests, ITFS distribution can be a compromise between total local control and the absence of user control inherent in ETV distribution.

Although CATV utilization in schools has been meager to date, research indicates that one of the more popular uses has been to have CATV headends play back tapes of ETV programs at times convenient to schools.[35] Also, it is common practice for school systems to contract with ETV stations for production and broadcasting of courses. This is something of a reaffirmation of an earlier comment in this memorandum, to the effect that direct financial support from users, rather than from a third party, yields more responsiveness to the needs of users.

These experiences should convince us that no satellite-based educational delivery system can be expected to achieve a significant measure of success if there are not provisions for local scheduling, either through user recording capability, repetitive scheduling, or user-activated distribution, as in dial-access retrieval. This is not to suggest that operator-scheduled distribution would be inappropriate for all situations. Educational programming of an informal nature intended for home reception, for example, probably lends itself to this mode of distribution more than does formal instructional programming intended for classroom use.

It has been said that centralized control might be acceptable, even desirable, in order to remove control from low caliber teachers. But forced feeding of programs to students through or around poor teachers does not seem an appropriate response to the problem of teacher incompetency, especially in an era of teacher surplus. Justification might also be made on financial grounds. That is, recording, dial-access, and repetitive scheduling all cost money. But if operator scheduling results in low utilization levels or inflexible learning environments nothing will have been achieved by taking the least expensive course of action.

Such educational uses of electronic delivery as computer-aided instruction or information retrieval from libraries and data banks are inherently user-initiated; and centralized scheduling is not a likely alternative, although consideration has been given to the possibility of continuously repeated display of some materials, so that distribution would continue to be operator-initiated, but so that users would have wide latitude in choosing when to utilize the services. Such a procedure would seem to make the most sense for materials for which demand is heavy and evenly spread over a length of time.

2.5.2 Localization of Decision-Making

One other aspect of this access factor which has been termed "control" is the matter of where the power to make certain policy decisions is to be lodged. This has importance for both user and producer/distributor. Except to be identified as a major factor, the matter will not be treated with depth here. It should be noted, however, that a tradeoff between supplier and user interests is involved in the issue of how much centralization is warranted. If the decisions on what to program over the system are centralized, the producer/distributor has an easier marketing task before him. He need only convince one or a few centralized policy makers. By selling these centralized "kingpins" the distributor gains access to the entire market. From the viewpoint of the user, however, the more centralized decision-making becomes, the less responsive the system becomes to local needs.

However, the tradeoff is not quite as clear-cut as that. It should be said that the marketing task is easier in a centralized system for the successful distributor. The other side of that coin is that the supplier who fails to sell the "kingpin" loses the entire market. The anti-competitive effects of this might be considerable.

Inasmuch as it is essential that a large number of distributors each have access to as many users as possible and that users have as much control as possible, a system needs to be structured that will promote both interests.

Such a system may be possible by centralizing storage but, at the same time, leaving the decisions about what to store up to distributors and decisions about what to distribute up to users. In effect, there would be no one "kingpin."

2.6 Access: A Concluding Remark

More space has been devoted to discussing the question of access than to any other issue raised in this report. It is the author's belief that "access" is what large-scale delivery is all about. The fundamental design objective is to make more educational services accessible to more people more efficiently. In a sense, every other central issue considered in this report is related to the problem of promoting access.

3. Integration

3.1 Introduction

Business firms often find it advantageous to control more than one step in the total production process of their respective industries. Such vertical integration can take the form of either "forward integration," in which a producer seeks to assure itself of a market for its goods by owning retail outlets, or "backward integration," in which a producer seeks to guarantee an uninterrupted supply of production materials by owning sources of supply.[45]

As illustrated in Figure 3, Hughes Aircraft is considering a plan which, if adopted, would be a vivid example of both forms of vertical integration in the communications satellite industry. Under the plan, Hughes would use eight channels from its proposed satellite service to distribute specialized programming services to CATV systems across the nation. The programming would be provided by the Hughes Network, which currently specializes in producing sports programming. The program specialties envisioned by the plan include children's programming, public affairs, religious programming, foreign language instruction, hobby and "how-to-do-it" information. Having guaranteed itself a source of program material, Hughes might be in a position to assure itself of outlets for those program materials through its 17 per cent ownership in Teleprompter Corporation, the nation's largest MSO (Multiple-Systems Operator) CATV company.[46] The means of transporting the programming from origination point to CATV headend is assured by Hughes ownership of the satellite segment as well as the earth terminals. With the exception of the user component, Hughes would integrate virtually every step in the satellite communications process. The advantages for Hughes, not the least of which is a guaranteed volume of traffic sufficient to make the Hughes satellite economically viable, are readily apparent. Now we should address the question of what degree of integration would be optimal for an educational telecommunications system. First, it should be noted that there are two tracks of integration with which we need to be concerned: Components and Functions.

As shown in Figure 4, "Components" include those which we have previously identified: software producers and distributors; storage/origination; transmission; local/regional distribution; and users. "Functions" are areas of responsibility within each component of the "distribution core." "Distribution core" refers to storage/origination,

FIGURE 3

A PROPOSED INTEGRATED SATELLITE SYSTEM

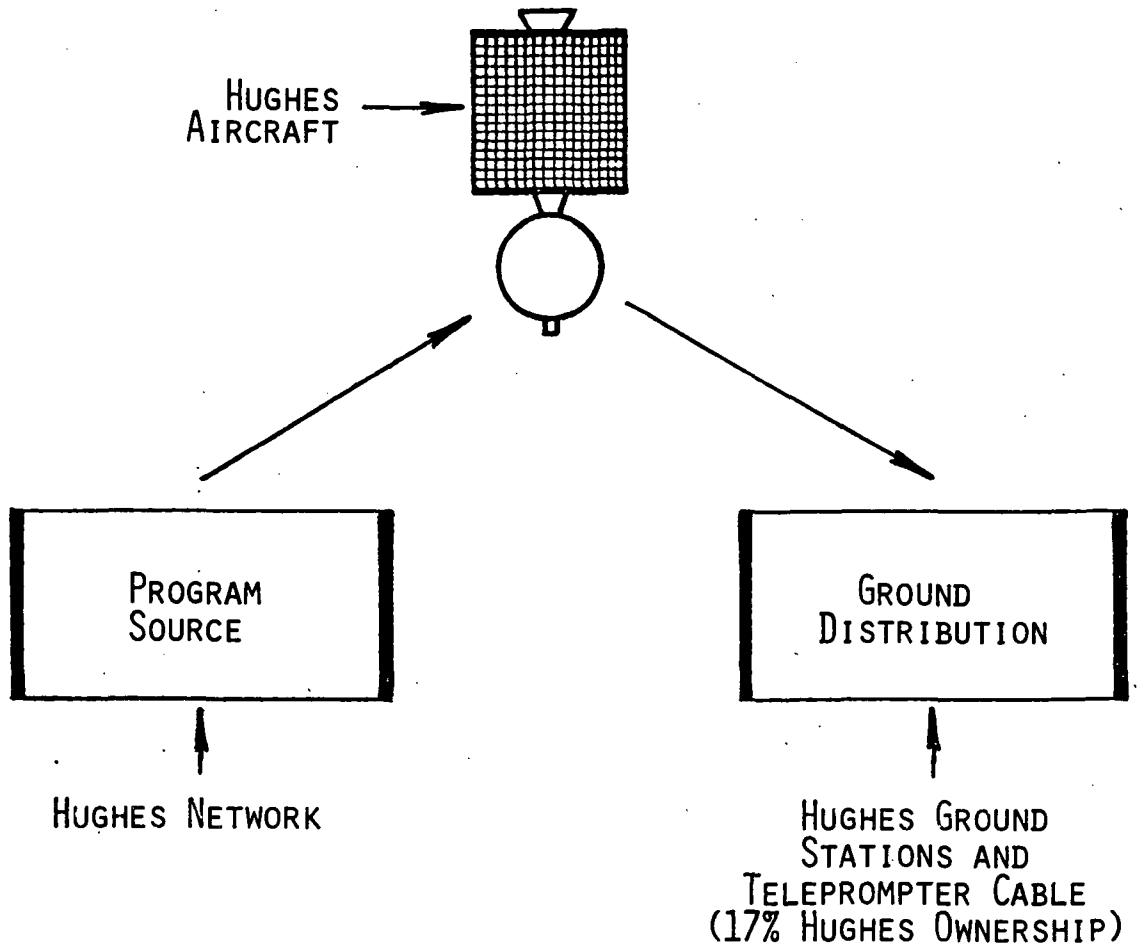
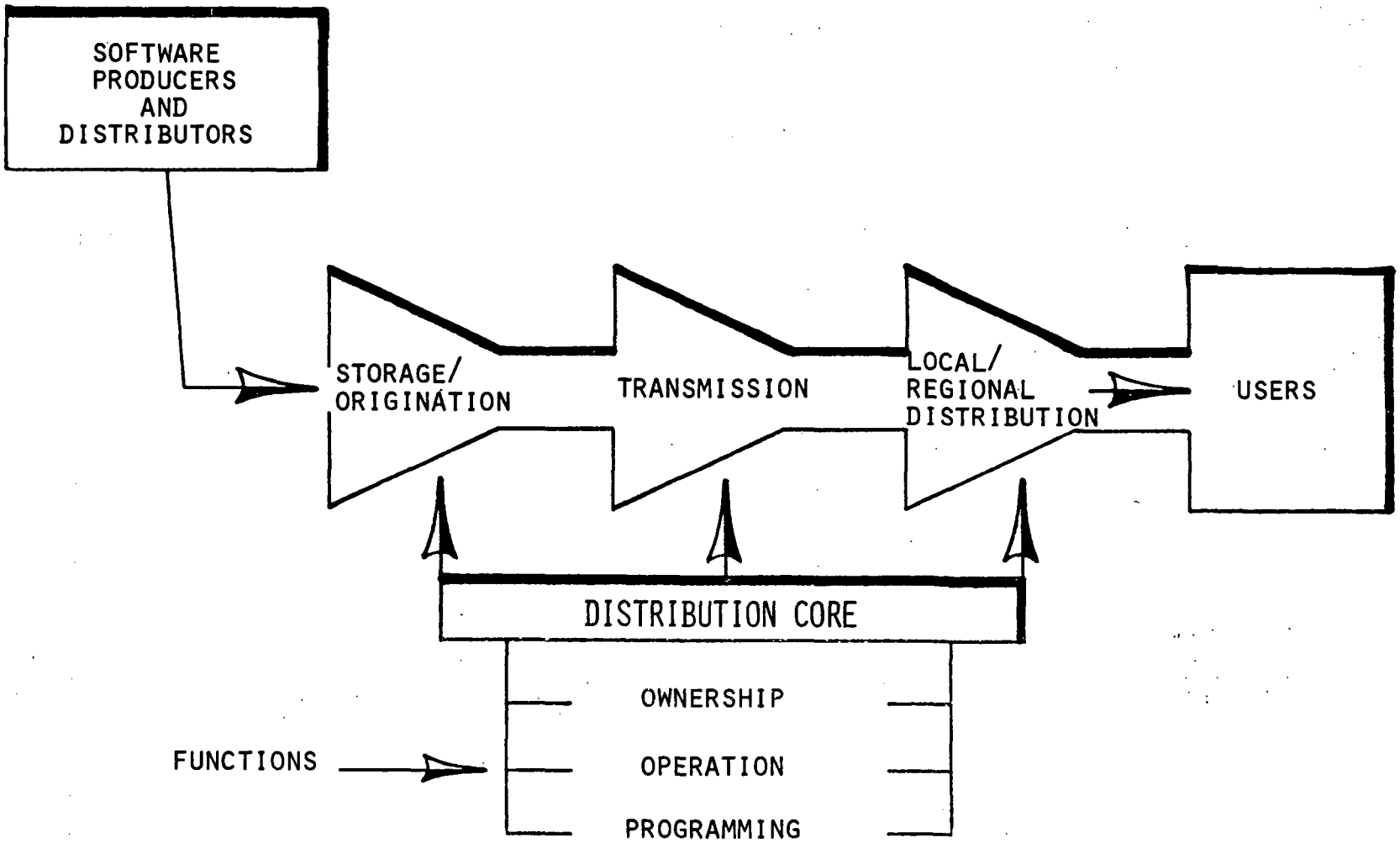


FIGURE 4

EDUCATIONAL SATELLITE SYSTEM: COMPONENTS AND FUNCTIONS



transmission, and local/regional distribution. The three areas of responsibility (functions) for these core components are ownership, operation, and programming.

As an illustration of a totally segmented educational telecommunications system, there could be a configuration in which producer/distributors and users would consist of a wide diversity of suppliers, individuals and organizations, none of which would have any formal control over any of the others or over any of the "distribution core" components. Likewise, each core component would be separately controlled. In addition, functions within each component would be divided. For example, the storage/origination component could be owned by state education agencies, with day-to-day "housekeeping" operations handled by a private organization franchised by the education agency, and policy decisions concerning circulation of software made by a special commission. Total integration, on the other hand, could exist if the federal government, represented by U.S.O.E., were to produce the software and own and operate all the storage and distribution facilities.

While most of the configurations that come to mind separate users from the rest of the system (i.e., the users are the served and the remaining components are the servant), it is conceivable that even this distinction could be erased. For example, a consortium of members from a geographically dispersed ethnic group could produce software for distribution to its members from a storage/origination headend belonging to the consortium. Distribution could be through leased satellite and cable channels.

It is worthwhile to consider some of the ways integration might be employed to bring about a viable educational telecommunications system and to also note some of the negative consequences of integration that should be planned out of the system.

3.2 Prospects for Integration, Positive Aspects

The legitimate role of integration is to reduce the risk inherent in being dependent on externally controlled factors for the smooth flow of information through the system.

If it is assumed that it would be desirable for private enterprise to have a significant role with respect to one or more of the system components, then it should be kept in mind that an organization whose survival depends on financial success cannot afford to take on as big a risk as might be taken on by a government subsidized non-profit organization.

A company deciding whether to develop software for the system will weigh the profit potential of doing so against the risk that there will be no market for the software at the user end or that satellite and cable channels for distribution will not be available on favorable terms. The private satellite operator would have to consider whether or not there is likely to be sufficient traffic to make his system economically viable.

Even the non-profit satellite operator should explore these questions, since the answers give some indication as to whether or not a given system makes sense.

Looking at the situation from the private software developer's point of view, integration with the satellite component does not seem to be a plausible alternative. The decision on whether or not to develop software for the educational communications system market would, in this observer's opinion, hinge more on the question of user demand than on the availability of satellite capacity. With the exception of Hughes, there is a noticeable absence of interbreeding between the software industry and the satellite industry, which is dominated by aerospace or communications carrier firms. Furthermore no single software supplier could produce a high enough volume of traffic to justify control of a satellite system of even minimum efficient size. Storage facilities, however, could conceivably be controlled by the satellite operator. Integration here could reduce the satellite operator's retrieval costs since no handling charge would have to be paid to a separate storage facility operator. Partial integration, in which the storage facility hardware would be owned by the satellite operator, with management of the facility in other hands, could lead to economies of scale through uniform large-scale procurement. This advantage would come forth especially in a system with a relatively large number of storage facilities dispersed throughout the country.

The most apparent opportunity for achieving the conveniences of integration between software and another component is in the local distribution area, specifically CATV. There are two reasons for making this statement. First, CATV companies will be looking for program material capable of attracting subscribers. Entering the educational software business may be one way of obtaining that material. Secondly, unlike the domestic satellite applicants, CATV operators have a close affinity with the software industry. The largest 50 CATV operators have among their ranks such broadcast or motion picture-oriented firms as Viacom International, Inc., Cox Cable Communications Inc., Warner Communciations, Time-Life Broadcast Inc., United Artists, Westinghouse, and Triangle Publications.[47] Other leading CATV firms who have exhibited strong interest in educational programming are Teleprompter Corporation (with its Hughes ties and its cooperative efforts with Eduplex Inc., an educational service company), LVO Cable Inc., (active in the library information services area); and Cablecom-General Inc.[35]

The other likely opportunity for component integration is between satellites and earth terminals. An examination of the domestic satellite proposals reveals an almost unanimous preference for integrated ownership of satellites and ground stations. The sole exception is the AT&T - Comsat proposal in which Comsat would provide the satellites, which AT&T would lease and operate in total.[23] The primary aim of common ownership of satellites and earth terminals seems to be achieving economies of integration by avoiding the need to procure service from another firm on unfavorable terms. Any satellite operator required to procure ground terminal service from a separate entity must incur extra distribution costs equal to the profit margin built into the ground

operator's tariff. That extra cost would, of course, be reflected in costs to users or, in the case of a publicly subsidized system, to the taxpayers. The desirability of having the satellite owner control ground stations would, therefore, seem to be applicable to a non-profit operator as well. With regard to low-cost reception terminals under direct control of users, the satellite operator need not be concerned about gaining access on favorable terms. But the reasoning holds for uplink transmitters or for any receive terminals located at midway distribution points not colocated with the ultimate delivery points.

3.3 Negative Implications of Component Integration

Vertical integration has a legitimate purpose, i.e., minimizing risk by assuring access to sources of supply and marketing outlets. This objective is shared by profit and non-profit entities, since both should be concerned with removing obstacles to smoothly flowing operations. So the question of integration is pertinent no matter who owns or operates the system. The technique of vertical integration can be used for purposes other than the one we have identified as legitimate. It can also be used to make the terms of access to sources of supply and marketing outlets so unfavorable as to curtail or altogether eliminate competition.

Cable/software supply integration could have such anti-competitive effects. For example, would Hughes software competitors be allowed to distribute their satellite transmissions to CATV systems in which Hughes has part ownership? If not, they could be excluded from 140 Teleprompter Corporation CATV systems[48] and more than 700,000 cable subscribers.[49] While this might not have a deleterious impact on competitors (they could program to other CATV systems), it would deprive users in communities served by Teleprompter of educational services provided by non-Hughes distributors. Hughes has indicated that its ground stations would handle Hughes traffic only and that it plans to distribute its program services to any CATV operator who wants them. But the programs would be made available only through the Hughes satellite distribution system.[23] Hughes has also indicated that unused satellite capacity could be leased by other program distributors. The danger arises from the fact that Hughes would be in the position of being both supplier and competitor for outlets. Since these competitor/customers would have to pay Hughes for the satellite service, their distribution costs and subsequent prices would be necessarily higher than Hughes prices. Hughes would be in a better position to offer attractive prices to CATV systems.

The Hughes plan has been singled out here simply because it is the only plan thus far to propose anything approximating a fully integrated satellite delivery system. It should be noted that Hughes Aircraft could function quite independently of Hughes Network. In all probability, Teleprompter would function as a wholly separate entity, developing its own programming as well as acquiring programs from outside sources other than Hughes.

It might be argued that the whole problem would be solved if the system were operated by a non-profit organization, since such an

organization would not have the motivation to squeeze competition out of the market. That argument would not be valid if the satellite and earth terminal systems were to be operated on a fee-supported basis by a non-profit operator which also offered some educational software. Since the other software distributors would have to include the satellite distribution fee in their prices, the user would find the prices of the non-profit organization's software more attractive.

It has been noted that commercial satellite operators would probably not get into the programming business. But the reasons for making that forecast (i.e., the technical orientation of satellite applicants) would not necessarily apply to a non-profit organization established for the purpose of providing satellite-based delivery of educational services.

A conclusion might be that an educational satellite system, whether profit or non-profit, should exploit the technique of integration where it will promote the smooth flow of services. The most likely combination would be satellites and ground stations. The combination which holds the greatest potential for undesirable effects is the integration of software supply with the distribution components. Even though permitting suppliers to control portions of the distribution system could foster software development, it should be avoided where the long run effect will be to decrease the diversity of software made available to users.

3.4 Integration of Functions

As noted in Section 3.1 and Figure 4, ownership, operation and programming are three functions to be performed in an educational telecommunications system for each of the "distribution core" components (storage/origination; satellite transmission; local/regional distribution). It has also been noted that it is probably very desirable to separate control over programming from control over the ownership and operation functions. There are two different reasons for this. One is that it seems most undesirable to concentrate in one place the power to decide what information should flow through a transmission system, especially if that transmission system is one of a kind (e.g., an educational satellite system) or if the system is owned and operated by an agency of the government. The other reason is that it is desirable to promote a diversity of software sources. It is conceivable that a system owner/operator might control the software selection and scheduling aspect of programming but not the production aspect. Such an arrangement would enable the operator to experiment with various combinations of services in order to discover a total package that would promote maximum utilization. At the same time, a diverse and competitive software production industry could exist.

Separation of ownership and operation may, at first glance, appear to be unnatural division of responsibility; but there could be occasions when it would be desirable. For example, one or more components in the system might be owned by government (not necessarily federal) and operated by a private entity under a franchise agreement. Another arrangement that would involve owner/operator separation would be a CATV system in which certain channels would be leased full-time to certain user

organizations, with the headend studio facilities manned by the lessor whenever production were required. This arrangement would, of course, turn over only some of the operational chores to the lessee since many operational functions other than production would remain.

4. General Organizational Alternatives

4.1 Introduction

Numerous types of organizations, ranging from government agencies to unregulated proprietary corporations, at both national and local levels, would be possible candidates for controlling satellite-based educational services. What little work has been done in the area of organizational design for an educational satellite system reveals a tendency to think in terms of some form of non-profit control, at least for the satellite part of the system.

Before any conclusions are reached about the merits of one kind of organization versus another, however, the various alternatives ought to be examined for their inherent characteristics and the circumstances which have brought about their employ in the past. No single type of organization is likely to be suitable for all of the components which might constitute a large scale educational satellite system, so consideration needs to be given to the total mix of organizational patterns that will best achieve "desirable" results.

The American economy is generally thought of as being based upon the private enterprise system. This does not mean, of course, that we totally reject public enterprise. Examples of public ownership are abundantly present at every level of government, from municipally owned water utilities to the U.S. Postal Service. In 1956, the Bureau of Budget reported that the national government operated 19,711 commercial-like enterprises.[50] Still, the principal means of production are in the hands of the private sector; and the public sector usually picks up where private enterprise leaves off, rather the other way around.

Public enterprises can be placed into two general categories. The first is the area of services which operate outside of the pricing system. Included here are such activities as defense, police and fire protection -- and, to a large extent, education. The other category involves production of goods and services which are sold for a price, sometimes referred to as market-oriented production. Examples of this kind of enterprise range from public utility services to retail merchandising in military post exchanges and state-owned liquor stores.

4.2 Rationales for Public Control

When the government does undertake an activity, it usually does so for one of the following reasons:

1. The service (e.g., national defense) is inherently a public good. That is, it is impossible to offer the service in the exchange marketplace, because there is no effective way to prevent those who choose not to pay from receiving the service once it is offered. If a person will receive a service whether he pays or not, there is no incentive to pay. So the activity must be supported by compulsory tax revenues.

2. The service is considered desirable but does not offer profit prospects sufficient to attract private enterprise. Special area development projects like TVA could be placed in this category.

3. Private enterprise is able and willing to provide the service but is also likely to engage in certain abuses, such as monopolistic pricing. Abuses might be controlled through regulation; but if regulation proves ineffective or too bothersome, it might prove easiest for government to own the enterprise. Public power utilities often fall under this category.

4. Government may choose to operate the service as a source of revenue. State liquor stores were originally intended as a means of controlling liquor traffic; but for some states they have proven to be lucrative sources of revenue.[50] State-run lotteries would be another example.

These are "textbook" rationales for government enterprise. They are not definitive explanations of the policy-making process, nor are they intended to be. Rather, it is hoped that they provide a useful framework for the analysis which follows.

4.3 Where Educational Telecommunications Fits

Does an educational satellite system or any of its components fall into any of the classifications described above?

4.3.1 Public Goods

By the strictest definition of the concept, satellites developed with public funds, the various ground distribution systems, and the software distributed by means of the system would not be considered public goods. Unlike the case of national defense, it is technically possible to exclude non-payers from the system. So, in this sense, no public good is involved.

In another sense, however, the educational services which would be rendered by the system are public goods. It would be possible to turn education into a saleable service from pre-school on up. But that has not been society's choice for primary through secondary education. Although private schools are available, universal basic education is generally regarded as involving certain benefits which are external to the individual learner and accrue to society collectively. Theoretically, at least, the individual would only pay for those benefits which accrue to him alone, and not for the externalities. If all individuals, rich and poor, were left to support their own educations, the aggregate private investment would be something less than adequate to meet society's collective demand for education's external benefits. Because of the externalities involved, the theory goes, it would be neither equitable nor workable to rely on the individual student to bear the entire burden of payment for his own education.[25]

Similarly, if communications satellites are utilized to improve educational opportunities in rural areas, and, consequently, migration from rural to urban areas is reduced -- who are the real beneficiaries? Rural people? Or urban dwellers who would perhaps be relieved of the burden of paying the cost to provide remedial welfare services to people who now migrate to the city without having the skills necessary to find jobs? If the benefit to urban dwellers is significant, how can we avoid making rural people bear the entire cost? One way would be through public ownership. But that is not the only way, of course. Tax revenues could be used to provide rural users with direct subsidies or to provide private enterprise with incentives to develop rural telecommunications services. So, although a telecommunications-based educational system exhibits some public good qualities because of the external benefits involved, the resemblance is not enough, in itself, to require public ownership.

4.3.2 Profit Prospects Insufficient to Attract Private Investment

If the system we seek involves a dedicated satellite component (that is, one devoted solely to educational uses), the combination of high entry costs and inability to make reliable estimates of near-term demand make private investment seem unlikely. As long as lower-risk opportunities with equal payoff potentials exist, it seems likely the investor would opt for the low-risk investment. The prospects for private investment would seem greater for the second generation of educational satellites, once demand has been generated. So public ownership, may initially be the most feasible alternative.

With respect to other components, however, the case for public ownership on the basis of inability to attract private investment is not so strong. In the case of local distribution by cable television, the commercial risk involved is less, because these systems are not currently or likely to de dedicated to educational services. Most likely, in the overwhelming majority of cases, cable distribution of educational services is going to be through privately owned multi-purpose systems.

If some communities decide to own cable systems rather than to award franchises to private entrepreneurs, it is not likely to be for lack of ability to offer profit prospects. In fact, it might be for precisely the opposite reason.

Depending on the system configuration involved, terrestrial microwave "tails" may be required. Private enterprise already has a substantial presence in the field. With the entry of such specialized carriers as MCI and DATRAN, users should benefit from the increasingly competitive prices and services. Nevertheless, microwave extensions from heavily used commercial trunk lines to sparsely populated areas may have to be owned or subsidized by noncommercial entities, due to the low traffic potential.* Instructional Television Fixed Service (ITFS) systems are, by definition, dedicated systems and almost invariably owned by the educational institutions or districts which they serve.

It is apparent that ground distribution is a mixed bag of public and private ownership and that the profit potential significantly depends on whether or not dedicated systems are involved. When installation of a service exclusively for education is involved (as in the case of some local microwave extensions, ITFS and over-the-air ETV) then private capital is not likely to be attracted. Where facilities serve educational and non-educational users alike, private investment appears to be more likely, as in the case of intercity microwave and cable television.

As for the software component, we simply do not know what the private sector attitude is or will be toward development of materials for a large telecommunications-based system. According to a 1970 article by McGraw-Hill's Robert Locke, total annual sales of educational products were estimated to be about $1.5 billion per year; and no single

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* If a dedicated satellite system comes about, receive-only satellite earth terminals costing only about $1500 could be located at the final delivery points, making microwave "tails" unnecessary for one-way services. Based on estimates of $4,000 for terminals capable of audio/data return and $12-20,000 for terminals capable of video return, it is possible even two-way services can be provided less expensively by direct user-to-satellite links than by microwave. Low power terminals capable of being mass produced for those prices were originally planned for use in the coming NASA/HEW educational technology demonstrations in the Rocky Mountain region. However, the uplink frequency required for such terminals could not be cleared for the purpose.[51]

company controlled more than 10% of the education market.* Some of the various market segments have been acquired by large industrial conglomerates such as IBM and Xerox, for whom the education business is but a small division. As Locke notes, "when one of SRA's (Science Research Associates) objectives comes into conflict with an objective of the parent company, IBM, it is not difficult to figure out which will be subordinated."[52]

On the other hand, the continuing presence of many large firms in the educational materials business indicates a feeling that something might happen to cause the educational market to become quite lucrative; and these firms appear to be ready if that something should happen. The chicken-and-egg question involved is whether the demand side of the educational market can flower without the advance availability of software, or whether the reverse can be expected.

In any event, it is difficult to envision a software component that would totally exclude the participation of either private enterprise or various elements of the public sector. Public participation will probably be needed for "pump priming," but total public control in an area so sensitive as information dissemination would be anathema to a substantial, if not majority, number of citizens. There is a need for an in-depth study of the outlook for private sector involvement in educational software and public initiatives needed to foster that involvement. By providing convenient access to potential markets, development of a large scale educational telecommunications system could, in itself, be the kind of initiative that would cause the private sector to invest in educational software.

4.3.3 Uncontrollable Abuses

Abuses by private enterprise, leading to either regulation or public ownership, can take the form of monopolistic pricing or "abuses of neglect." The latter category refers to the problem of siphoning off lucrative portions of a market while leaving less remunerative portions unserved. The "creamskimming" problem has been mentioned specifically with respect to the transmission component of an educational telecommunications system.[8] Because of the "natural monopoly" character of a dedicated educational satellite segment, the concern is that a commercial operator might charge excessively high prices in serviced

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* It should be kept in mind that, while no company controls more than 10 percent of the total educational market, control may be more concentrated in certain sub-markets. For example, two firms, McGraw-Hill and Encyclopedia Brittanica, are reported to control 60 percent of the educational films market.[53]

markets and not serve remote and sparsely populated areas at all. The problem would perhaps be more severe for placement of expensive receive/transmit terminals than for the satellite segment itself.

It needs to be asked whether prevention of abuse is, by itself, a valid rationale for public ownership of the satellites and ground stations or any other component. In favor of public ownership of some form, it might be said that the only alternative way to prevent the abuses of neglect and monopolistic pricing, regulation, is usually slow and costly[54] and that regulatory bodies have a long-run tendency to identify with the interests of the business they regulate rather than with the public interest. It might also be said that regulatory agencies are usually too under-funded to effectively regulate even when they have a mind to.[55] An additional consideration, besides the shortcomings of regulation, might be the argument that a public owner is more likely than the private owner to think in terms of the public interest than a private enterpriser whose main consideration is profit.

On the other hand, one could concede the shortcomings of private commercial ownership and regulation but argue that the public ownership cure is worse than the disease. "Market-oriented production in the political economy undertaken to minimize abuse rather than as a means of positive achievement," writes Robert Solo, "is hardly likely to be characterized by dynamic management nor any strong motivation toward technical progress."[56]

One should consider the possible vulnerability of public enterprise to political pressures and costly bureaucratic excesses. While it is true that prices charged by a private corporation would have to include a profit margin, a question arises as to whether a public enterprise, lacking incentives for efficiency, might not have to charge equivalent or greater prices. An independent public corporation, self-supporting, and free to dismiss incompetent or surplus personnel, might be able to avert these problems; but given its monopolistic nature and subsequent ability to raise prices to compensate for inefficiency, the adequacy of self-support as an incentive for efficiency is questionable.[57]

Although other reasons, such as private enterprise reluctance to develop the market or the need of private enterprise to structure a profit into its prices, may justify public ownership, a case that public monopolists are less self-serving operators than private monopolists has yet to be made before public ownership can be justified solely on the grounds of private enterprise abuse.

4.3.4 Government Enterprise as a Source of Revenue

There is no reason to believe that the opportunity for revenues would be a motive for establishing public ownership of the components in the educational telecommunications system, with the possible exception of cable television. At least eighteen communities have taken, and others are considering taking ownership of cable TV in their respective

jurisdictions, some for the purpose of raising revenues to compensate for deficits in other community services.[58] The total number of systems and subscribers who will be affected by public ownership will probably be small. It is difficult to tell whether this would benefit or hurt the educational telecommunications system. One might speculate that a publicly-owned CATV system which uses CATV profits to cross-subsidize other community services, rather than to support additional CATV services, might not be as generous to the educational community as another system might be. But there is no evidence to support such a guess.

4.4 Alternative Types of Organizations

There are several distinct variations within the public enterprise - private enterprise dichotomy to be considered:

4.4.1 Government Agency Model

The government model is characterized by direct supervision from the executive arm of government. The Federal Aviation Administration under the Department of Transportation, as an example, operates and maintains the Washington National and Dulles International airports. In addition, the FAA owns airport control towers, instrument landing systems, radar and other navigational aids at airports across the country.[59]

Conceivably, a government agency such as the Office of Education could own storage/origination headends in a telecommunications system. Or an executive agency could be created to operate the transmission system. It is generally believed that government departments should not be involved in operating business-like activities. They offer no insulation from political influence and are subject to the rigidities of civil service practice. To the extent that they are able to tap tax revenues rather than user fees for financial support, they lose incentives for efficiency.

Nevertheless, if consideration were being given to turning the satellite component over to private enterprise after the initial development stage; or if government were to own the satellite component, with private enterprise operating it, the government agency model might have merit. It would avoid having to temporarily establish a separate public corporation.

4.4.2 Government Corporation (TVA Model)

This is the most common form of public ownership. City-owned power utilities, the Commodity Credit Corporation, Federal Prison Industries, Inc., Federal Deposit Insurance Corporation, and Tennessee Valley Authority (TVA) are but a few examples.

The rationale behind these corporations is that they have more freedom to operate in a business-like atmosphere than do government agencies. In the case of federal government corporations, stock is issued to the Treasury Department in exchange for funds. Management is through presidentially appointed boards of directors. For TVA, Treasury financing has ceased. Operating and capital investment funds must be raised through the sale of services and bonds in the private market.[60]

Being a separate corporation, TVA can sue and be sued, can hire and fire without Civil Service restrictions and can own property.[50] The TVA also makes tax-like payments to state and local governments, although it is exempt from paying federal taxes.[60]

4.4.3 Public Non-Profit Corporation (CPB Model)

A significant distinction between a TVA model and a non-profit corporation such as the Corporation for Public Broadcasting, is that the TVA operates like a business, raising revenues by placing a monetary price on its services. The Corporation for Public Broadcasting, on the other hand, has no commodity to sell and is funded through gifts, grants and Congressional appropriations. CPB is, in fact, established as a private corporation under the District of Columbia Non-Profit Corporation Act. The term "public" is used here because the corporation's directors are appointed by the President and significant financial support comes from Congressional appropriations, making public sector participation predominant.

Because CPB is not in the business of selling products to individual consumers, a fee-supported educational telecommunications service would be closer to a TVA model than to a CPB model. But this is not to say that a non-profit corporation could not be set up to be supported primarily by user fees.

Until very recently, a unique feature of CPB has been its status as an intended buffer organization. That is, Congress appropriates funds for the Corporation; but the funds have been channeled by CPB to the Public Broadcasting Service (PBS) and National Public Radio (NPR), which are responsible for day-to-day network operations. In the past, this responsibility has included the selection and scheduling of programs. CPB also channels funds to public broadcasting stations and program developers such as the Children's Television Workshop. By law, CPB is prohibited from owning or operating any broadcasting stations, interconnection systems or program production facilities.[61] The intent of the buffer arrangement is to insulate the operating elements from direct political pressures. Recently, however, CPB has taken a different view of its role and has moved to more directly involve itself in the selection of programs to be aired over the television interconnection system. The corporation has accomplished this by refusing to fund programs it considers unsuitable for public television or too low on the list of priorities to qualify for a share of limited available public

funds.[62] The wisdom, if not the legality, of these steps has recently been a subject of great controversy. Negotiations among the various parties involved are underway and the final outcome remains to be seen. The experience of public broadcasting, which has had both successes and controversies about government interference and centralized versus decentralized control, should be kept in mind by educational telecommunications planners.

Using the original CPB buffer arrangement as a model, it is possible an educational telecommunications system could be supported by a mix of public funds and user fees. In this case, a CPB-type organization could be established to receive funds from government and private benefacters and to disburse funds among users. A second tier corporation, modeled after TVA would then provide the service and charge on an actual cost-incurred basis. Regional development organizations, such as the Federation of Rocky Mountain States and the Appalachian Regional Commission, building upon operational experience they will acquire next year with the NASA/HEW satellite demonstrations, could implement the second tier portion of the model on a sub-national basis. This would have the advantage of minimizing centralized political influence and would perhaps help to keep track of which services were or were not economically viable without sacraficing access due to inability to pay.

A plan similar to this has been proposed for financing public broadcasting, for much the same reasons. Under the so called "market plan" proposed by PBS President, Hartford Gunn,[63] federal funds would be disbursed by CPB to public broadcasting stations. PBS would supply a program when enough stations were willing to kick in the dollars to support the program. The effect would presumably be to achieve economies of scale through centralized program production, but to place program decisions in the hands of decentralized stations.

As an alternative, the funding corporation's money could be paid directly to the operating arm and user fees reduced. But users' "purse-string" voting power over decision-making would be lost.

4.4.4 Private Control with Public Participation (COMSAT Model)

Where TVA is a public enterprise with private participation through sale of bonds to the general public, the Communications Satellite Corporation (COMSAT) is a private enterprise with public participation through the presence of three presidentially-appointed members on the fifteen-man board of directors.[64] It is also a "for profit" corporation. The balance between public and private governance is another possible alternative to regulation of private enterprise. While it can be debated whether only three government selected representatives are adequate to represent the public stake in satellite communications, there is no reason why a more evenly balanced COMSAT model could not be established from an educational telecommunications network.

The justification for such an arrangement might be that the heavy involvement of private enterprise would be a more effective check against government interference than can be had in a CPB-type of corporation partially dependent on Congressional funds. At the same time the public would have voting representation, which would perhaps be more effective than regulation, if there were enough publicly appointed directors.

A variation on this, to decrease the risk of investing private capital, might be for the government to provide free ancillary services, such as satellite launching. If such a provision were written into the initial legislation, there would be little in the way of "purse-string" pressure that could be applied by partisan legislators or executive branch authorities.

There is a question, however, as to whether free ancillary services would be enough to bring the financial risks down to an acceptable level. But the principle could be expanded, in varying degrees, to the extreme case of all capital outlays being made by the public sector, with private enterprise responsible only for operating expenses. Such an arrangement would be unique to say the least; but uniqueness would not be sufficient justification for rejecting the idea. If it is thought that private enterprise is likely to be a more effective operator and that the possibility of political interference can best be kept in check by private control, the government/private enterprise partnership idea might merit consideration. To the author however, the idea of government paying for physical plant does not seem wise; that is, not unless government retains ownership and leases the system to the private operator. By retaining ownership and franchising a private operator, the public could select a new operator if the one initially chosen proved unsatisfactory.

4.4.5 Private Profit Corporation

Belief that government participation should be minimized and that private enterprise is potentially more efficient, hence, less costly than public enterprise would be the arguments for private control of one or more components. Additionally, a "pro-business" and "anti-big government" political climate could conceivably preclude any chance of a huge new public corporation.

As has been noted earlier, the justifications for public ownership are not likely to be prevention of private enterprise abuses or any "public goods" concept, but rather the inability to attract private capital due to dim profit prospects. For this reason, a purely private corporation model, unaugmented by public participation, seems unlikely for either the satellite or earth station segments of a dedicated educational telecommunications system.

5. Hardware Control

Decisions will have to be made concerning the ownership and control of equipment. At stake are the sensitive issue of local autonomy and questions of system efficiency. Basically the question boils down to whether equipment should be owned by users or issued to them under a lease or loan arrangement from either the system operators or a separate entity.

Regarding this issue, the hardware elements with which the system planner needs to be particularly concerned fall into three categories:

1. Uplink transmitters and downlink receivers and associated interface equipment.

2. Source appliances (recording and production equipment; CAI program storage and data bank computers).

3. User appliances (video and audio record and playback machines local minicomputers, CAI terminals, and other display hardware located at the ultimate consumption points).

The AVSIN (Audio-Visual Satellite Instruction) system developed by DuMolin[8] calls for the AVSIN organization to retain control over all reception terminals, which would be leased to users. The organization would provide for installation and maintenance of the equipment. In support of this plan the author spelled out three important considerations.

First, by leasing equipment, which is expected to be expensive, users would be able to amortize costs over a long period of time. This would be especially advantageous to less affluent users, who might not be able to afford the equipment under a buy arrangement. Second, much of the equipment will be highly complex, requiring the skills of highly trained technicians for proper installation and maintenance. AVSIN could provide this talent and assure users of speedy repair service in the event of a breakdown. Third, AVSIN control would enable the organization to design the communications system so that a signal from the satellite would be required to activiate recording equipment at the user's station. This would serve to prevent the "free-loading" which plagued the MPATI project.

There are other possible advantages. Toffler has described an accelerated trend towards what he labels "rentalism,"[65] a growing tendency for Americans to rent rather than buy things. As a result, Toffler speculates, there could be a reversal of planned product obsolescence and an increasing concern on the part of manufacturers for product reliability. It seems reasonable to assume that a manufacturer who leases a product to a consumer will try to maximize lease income by minimizing down-time for maintenance. He can achieve this first by designing the product so it is less likely to break down and, second, by giving prompt repair service when a breakdown does occur. One incentive which would not exist under the AVSIN plan would be the knowledge that a dissatisfied customer could terminate the lease and go to

a competitor. For this reason, it would be wise to provide solid contractual guarantees of fast repair service.

Another possible advantage would be that, with all hardware being supplied by one source, it would be easier to achieve compatibility throughout the system. One of the reasons the educational technology revolution foreseen in the early and middle 1960's has never quite happened is the lack of hardware standardization. Half-inch videotapes that cannot be used with one-inch machines, various shapes and sizes of videocassettes and computer programs that work with only one kind of computer system inhibit development; because users are limited in the pre-packaged software they can use with their equipment, and because would-be software producers are limited in outlets for their products.

Still another reason leasing rather than buying could be attractive to a user is that it would enhance his flexibility to adopt technological innovations as they come along instead of waiting for purchased equipment to wear out. Leased equipment can simply be turned back in when the lease agreement terminates. Purchased equipment cannot be so readily disposed of without incurring a financial loss.[43]

A final advantage to leasing from a central organization like AVSIN is that by buying equipment in large quantities the organization might be able to obtain quantity discounts, on the grounds that large single customer orders are cheaper to transact than many small orders. Also, production schedules can be set up more economically for large orders; and the manufacturer is more certain of his market.*

All this having been said in favor of leasing from an AVSIN - type of organization, it is necessary to note that such an arrangement is not without shortcomings. While some users may welcome the opportunity to obtain equipment by leasing, others may well want to preserve their autonomy by purchasing equipment. It may be easier for a less affluent user to make lease payments than to buy equipment; but, in the long run, his lease payments may total more than the purchase price. There is a certain amount of justification for this if the lessor assumes greater maintenance responsibility and the risk of having a lease terminated.

In a situation where one supplier (AVSIN) controls the supply of equipment and the choice of procurement means is restricted to leasing, the lessor is in a position to exploit the situation. Under these circumstances, the lessor may feel unrestrained in setting the rental price and uncompelled to offer attractive maintenance terms. There would probably be less reason to worry about this with a non-profit organization like AVSIN than with a profit-seeking corporation.

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* Much of this discussion on the pros and cons of leasing and buying is based on a book by Sharpe.[66] The interested reader is directed especially to Chapers 6-8.

It would appear that there is considerably more justification for the system operator to control the hardware up to and including the downlink receivers than for him to control the user or source applicances. Control over the placement and activation of reception equipment would enable the system operator to minimize unauthorized use. However, removing the user's option to buy equipment could bring a strong negative reaction from the public. It might even raise significant legal questions in view of antitrust cases in industries as disparate as computers[66] and shoe machinery,[67] in which companies were required to make any equipment available for lease also available for sale.

Justification for the system operator to control appliances would be the economies of large-scale procurement and the expeditious achievement of standardization. However, other ways will probably have to be found to achieve standardization of hardware. The telecommunications system itself may be a powerful incentive for the "learning industry" to work toward standardization. Among the recommendations made by the Commission on Instructional Technology in 1970 was that a National Institute of Instructional Technology (NIIT) be established as a part of the proposed, since established, National Institute of Education. One of the functions of NIIT would be to bring "learning industry" representatives and educators together for the purpose, among others, of establishing standards for instructional equipment. If this could be accomplished, it would seem a more acceptable route to take than placing responsibility for all system hardware under the control of a single entity.

If the standardization problem with appliances can be solved by industry cooperation or some other means, the only equipment that would not be provided competitively in the open market place would be transmission equipment (i.e., satellite earth terminals and associated hardware). In a system mixed with low-cost receive-only terminals and expensive receive/transmit terminals, the low-cost receivers might be bought, sold and leased on a competitive basis; while receive/transmit stations would be controlled by the system operator. Activation would be initiated by the user when he requested material or tuned into a scheduled distribution through a signal de-scrambling device provided by system operators. Billing would be automatic, operating much in the same way as telephone billing works now. An alternative, remotely activating user stations from the other end (i.e., the source end) of the communications system would raise the spectre of privacy invasion. In a primarily one way system, source-activated equipment would present the user with more of an inconvenience than a threat of privacy invasion. The privacy problem would arise in a 2-way system in which the terminal could be activated without the user's request or knowledge, thus giving the source a chance to monitor users.

6. Development Strategies

6.1 Introduction

By "development strategies" is meant initiatives which can be taken by government to start the ball rolling on a satellite-based educational delivery system. The strategies which we will enumerate are, for the most part, methods which have been resorted to in past situations where public policy was to encourage rapid introduction of an untried technology. Some of the techniques are inherent in the organizational forms discussed in section 4. They fall into four main categories: (1) public control; (2) financial incentives; (3) demonstrations; (4) marketing assistance.

6.2 Public Control

The most direct way to start up a system is legislative fiat. Establish an organization and appropriate the funds needed to build the system. Some of the pros and cons of public ownership or quasi-public control like CPB were discussed earlier, and they need not be repeated here. It goes without saying that there are limits to what can be legislated into existence. Because it probably will not be possible or acceptable for the public sector to control all system components, and because use of the system cannot be decreed, other strategies are necessary to encourage the participation of private enterprise and users.

Another public control strategy is regulation. In this category would be such policies as requiring CATV operators to provide channels for use by the system, preferential rate treatment for educational users from commercial satellite systems and other communications carriers and service to unprofitable markets. It should be noted that the FCC, in its Memorandum Opinion and Order in Docket 16495 of December 21, 1972, declined to require the commercial domestic satellite applicants to file specific proposals regarding preferential rate treatment for public broadcasting, educational or other public service users. Although such a requirement might be a future possibility, the Commission does not feel it currently has enough information upon which to base specific rate policies.

6.3 Financial Incentives to Private Enterprise

6.3.1 Research and Development

Any action which would reduce risks for a private entity by having the public sector share the financial burdens of doing business would fall into this category. One such incentive which continually benefits private enterprise but which often goes little noticed is government-sponsored research and development. R and D as a form of subsidy is

sometimes desirable not only because private enterprise is spared an expense which could make the difference between starting up and not starting up, but also because private industries, while frequently very adept at applied research, are not geared for basic research where outcomes and even objectives are uncertain. And some R and D efforts, such as those involved in the space program, are so massive and multi-faceted in scope, as well as in benefits, that no single firm could be expected to bear the cost. It is almost inevitable that private enterprise will be the beneficiary of some taxpayer-supported R and D.

Research and development subsidies could be a deliberate policy enticement to private enterprise participation in an educational telecommunications system. The recently established National Institute of Education will hopefully stimulate much in the way of educational research. A directive to NASA to furnish R and D services to an educational satellite system operator could be issued in special legislation. There would be nothing new in this. Section 201 of the Communications Satellite Act of 1962 directs NASA to ". . . cooperate with the Communications Satellite Corporation in research and development to the extent deemed appropriate by the administration in the public interest. . ."

6.3.2 Below-Cost Services

Other subsidies could take the form of free or below cost ancillary services mentioned earlier. Taxpayer-supported storage/origination services could be an inducement for program distributors to make materials available through the system. A parallel can be found in the postal service, which, in past years, has provided delivery services to magazines and newspapers at below cost rates. The reorganized postal system has announced plans to make these publications bear a greater share of the actual cost of delivery; and publishers have protested on the grounds that low rates are necessary to encourage wide dissemination of publications to keep the citizenry informed.[50] A similar argument could be made by operators of an educational telecommunications system and software distributors.

Although the incentives mentioned in this section are primarily directed at the seller rather than the consumer side of the market, either direct payment or reduced cost services to users are, in effect, indirect subsidies to the sellers, since the government-induced demand would impact the seller's revenues.

6.3.3 Cash Operating Subsidies

Cash payment subsidies which have been made to the airlines illustrate yet another alternative strategy which government could employ in an educational telecommunications system. Beginning in 1930, government paid a mail subsidy to airlines to promote the development of air passenger transportation. Previously, subsidies had been paid on the basis of the amount of mail carried. The 1930 formula was based on aircraft

capacity in order to encourage construction of bigger aircraft designed for passenger service. While mail subsidies beyond payment of carriage costs have ceased, the government continues to pay operating subsidies to local "feeder" airlines, to the tune of $41 million in 1970.[68] A public operating subsidy to satellite system operators who suffer losses could pay the difference between operator revenues and costs, with the size of the subsidy being de-escalated as the volume of traffic increased. The effect would be to enable operators to provide room for growth capacity and service without making the user directly bear the high per user costs inherent in a system with high fixed costs and low traffic volume.

6.3.4 The REA Approach

In the category of financial incentives, one additional instrument is the use of government loans made available on favorable credit terms. When Congress established the Rural Electrification Administration as a lending agency of the U.S. government in 1936, only 11% of all farms were electrified. Today, electrification is more than 98% complete.[69] Legislation designed to promote expansion of cable television into rural areas by making long-term, low-interest loans available through the government in a manner similar to that of the REA program has been proposed by U.S. Representative Robert O. Tiernan.[70] Potentially, this could be significant for an educational telecommunications system, since many rural areas currently lack the local distribution systems needed to take advantage of services that might be delivered point-to-area by satellites. In addition, the approach could be utilized to promote development of the satellite segment itself, ground stations, storage centers and user comsumption points. A few more features of the REA approach have some relevance for the educational telecommunications system.*

First, though the REA has achieved its purposes, its success did not unfold in the manner initially envisioned. The original idea was to provide loans to private business as an inducement for them to deliver electrification to rural areas. But private enterprise showed little interest. As a result, most REA borrowers turned out to be non-profit consumer cooperatives. Depending on the extent to which government undertakes ownership of the educational telecommunications system, the user cooperative approach may have merit for the network. If, for example, the satellite operator did not own the ground receivers, a

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* Although the REA experience remains pertinent to the subject of development strategies for educational telecommuncations, it should be noted that the National Administration recently announced important changes in the REA program. Government loans formerly available at 2% interest are to be made available at 5% interest and financed through the sale of government securities to private investors.[71]

combination of attractive loans and user-owned ground distribution systems could develop, especially in thin-market areas. Such cooperatives could control more than earth terminals. They could also invest in local and area microwave systems and, perhaps, even CATV.

Second, the REA has provided loans to borrowers for re-lending to household consumers in need of financing for installation of wiring and electrical appliances. This suggests an alternative for subsidizing users. Government-to-user subsidies involving either direct or indirect grants were mentioned earlier. The REA approach would put the responsibility for developing utilization on the shoulders of system operators. Lending funds could be channeled into community or regional cooperatives, which would re-loan money on low-cost terms to users for purchase of CAI equipment, TV sets, videotape machines and software. Money could even be loaned to software developers. The same approach could be used for disbursement of grant money. Such an arrangement would have the effect of decentralizing the process of allocating funds and would be well-suited to the "special revenue-sharing" concept advocated by President Nixon. Three possible benefits would be (1) to make the system more attractive in a political climate favoring decentralization of government power; (2) to bring the funding agent closer to his clientele, hence, possibly making him more aware of and responsive to users' needs; (3) to give local and regional operators the power to directly offer financial incentives to potential users.

Third, when the REA was being planned, the government learned that, without private power industry participation, there was a shortage of people trained to build and operate rural electric systems, the Rural Electrification Act provides for the REA to advise borrowers in engineering and management matters.[69] Similarly, Section 331(b) of the Tiernan "cablefication" bill[70] provides for the publication and dissemination of information concerning cable TV and for technical and advisory assistance to eligible cable TV systems, including assistance in preparing applications.

Certainly the plans for a nationwide telecommunications system for education should include this kind of user support. "Field support services" of this nature are planned for the Applications Technology Satellite (ATS-F) demonstrations in the Rocky Mountain region. The results of those efforts should help to pinpoint some of the pitfalls involved in designing an effective user support model.

6.4 Service Demonstrations

Because of the revolutionary character of a satellite-based delivery system and the uncertainty of its acceptance, the attitude of private enterprise toward major participation is likely to be "show me." So, for that matter, is the attitude of potential users.

Efforts to meet that challenge are, of course, already underway. The demonstrations of the Applications Technology Satellite program have been designed primarily to demonstrate the technical feasibility of satellite-

delivered services. ATS-F education demonstrations will be the first test of high-power satellite and low-cost ground terminal configurations. In this sense, they will be technology demonstrations. But the Rocky Mountain program involves plans to deliver early childhood and career orientation education to different ethnically, geographically and linquistically identifiable population segments. Also, tests are being designed to measure acceptance of the satellite services and users' educational achievements. Some answers to educational as well as technical questions should result.

It is the author's opinion that there is a need for satellite demonstrations involving not only demonstrations of different services and media mixes for various audiences, but also different administrative and financial support schemes. Why not, for example, develop a demonstration in which users would pay for use of the satellite channels under various fee systems? A target user group would have to be carved out and isolated from other demonstrations offering similar services free. Some of the alternative subsidies which have been discussed could be tried in order to obtain a rough notion of how prospective users and suppliers would respond in a market situation. This market simulation approach would help to demonstrate to private enterprise the potential, or lack of potential demand for services offered in the price-directed marketplace. The validity of the results would be tainted somewhat because of the limited time available for generating demand and because of user awareness of the program's experimental nature. Nevertheless, a more realistic basis for projecting demand than currently exists might result. The knowledge obtained through such demonstrations would be useful even if private control of the satellite system were not anticipated. Indications of demand under realistic financial conditions are needed, no matter where control is to be lodged.

Regrettably, it does not at this time appear likely that there will be an opportunity to conduct such a demonstration anytime soon. ATS-F is the last of the ATS series. Plans are being made for some educational demonstrations on the Communications Technology Satellite (CTS) being jointly developed by Canada and the U.S., but those are the last educational satellite demonstrations scheduled so far. There had been plans for an ATS-G satellite and proposals for an ATS H/I series. However, on January 5, 1973, NASA announced plans to phase out communications satellite development work. Underlying that decision was the conclusion that private industry is now capable of handling future development. The cutback is also part of the government-wide effort to curb spending.

6.5 Turn-Key Operations

Service demonstrations with the planned ATS and CTS will be trial operations. If the concept of a permanent telecommunications-based educational delivery system involving a dedicated satellite segment is chosen, public ownership of satellites, earth terminals and storage/origination points may be required to get the system started. Should

it be decided that private control, if possible, would be more desirable, public ownership could be made a temporary arrangement.

There is precedent for initial public ownership and development of business enterprises with private enterprise later assuming control. Samuel Morse was unable to entice private enterprise to develop his discovery, so government started the telegraph industry with a hook-up between Washington and Baltimore in 1843. By 1847, commercial interests had become sufficiently convinced of the new technology's potential to enable the government to sell the business to private operators. The U.S. Post Office flew the mail from 1911 to 1925. During this time air routes were established, airports constructed, and aircraft improved. By 1925, an adequate foundation for private enterprise operations to take over had been established.[50] Similarly, the U.S. government entered the river transportation business with the enactment of the Inland Waterways Corporation Act of 1924. The act declared the corporation to be ". . .for the purpose of carrying on the operations of the government-owned inland canal and coastwise waterways system to the point where the system can be transferred to private operation. . ."[72] Shipping operations on certain portions of the Mississippi and Missouri Rivers required not only that service be provided to small port cities and low-volume freight customers whom private carriers had refused to serve, but also large-scale improvement of navigation channels.[68] This has some parallel with a telecommunications system in which private operation of a satellite segment would not be feasible until an adequate terrestrial communications infrastructure had been developed.

Government pioneering of an educational satellite system for later transfer to private hands is a possibility worth considering. A note of caution though. The government has sometimes moved toward private ownership at a sluggish pace. Transfer of the Inland Waterways Corporation operations to private enterprise took 19 years to accomplish, although some parties though the transfer could have been made much sooner. The delays were caused by fears that a private operator would curtail service to less profitable ports and by failure to find a buyer who would offer a reasonable price. When the corporation was sold, the conditions of sale required continued service to customers who had been served by the government corporation. Sale of a "turnkey" telecommunications system would probably also have to contain such a provision.

6.6 Marketing Assistance

The strategies which have been discussed to this point are aimed primarily at transferring the burden of financial risk from the private to the public sector. Use of the term "marketing assistance" is meant to suggest strategies which need to be employed to facilitate development of system utilization, whether the system be in public or private hands. They involve services which a private operator could provide on its own or which could be provided by public agencies in support of a private operator.

Once in place, the educational communications system can succeed only if there is an audience on the receiver end of the system. Stores

of software can be accumulated, elaborate transmission facilities installed, service terminals laid at the feet of potential users, and financial incentives to use the system offered -- all to little avail if audiences choose not to participate. In the final analysis, substantial continuing use will come about only if audiences want to participate. That stark reality requires first that the services provided be worth using and, second, that the users be made aware of the services and how best to use them. To these ends, the following objectives must be met:

1. Ongoing diffusion among prospective users of knowledge about the system and its potential benefits.

2. User involvement in the design of hardware, software packages, and system operations.

3. Advice to user groups from system operators or other agents concerning legal, technical, managerial and other matters involved in planning and organizing for system utilization.

4. Operational training for users -- how to run the machines.

5. Effective mechanisms through which to obtain clearance for use of copyrighted material.

6. Administratively painless request and payment schemes.

7. Storage, classification and exposure of materials and services so as to give them maximum visibility to users.

8. Users and needs identified so as to give them maximum visibility to distributors of materials.

6.7 Conclusion

One might ask after following these several pages of discussion about development strategies whether it is worth all that trouble to make the system a predominantly private enterprise operation. A skeptic could argue that such efforts amount to forcing a square peg into a round hole -- i.e., private enterprise into an inherently public undertaking. Indeed a case could be made that a system controlled by private enterprise but developed through the massive infusion of funds and the assumption of major risks by government would amount to a private enterprise facade. It might be predicted that such an arrangement would be an exhibition of how to design a framework that would combine the vices of private and public enterprise and exclude the virtues of each. Under conditions of heavy public underwriting of risks, it might be argued, the incentives for efficiency which are supposed to characterize private enterprise could be destroyed, with taxpayers picking up the tabs for the subsidies, for the lost efficiency and for a profit return. At

the same time, some extent of government "purse-string" power would remain, while the advantage of having a public operator responsible to users rather than to stockholders would be dissolved.

Although it is not the intent of the foregoing discussion to advocate one course over another, a number of trends seem to point toward placing the system, if there is to be one, under private control. The present national administration has persistently supported the notion that the private sector should be the caretaker of the economy, including many activities that have traditionally been considered public sector responsibilities. It is possible that a future administration will be guided by a different philosophy.

Recent adverse publicity about a proposal to wire every home into a national disaster warning system[73] provides some indication of an increasing sensitivity to the implications of government (especially national government) control over information channels. Controversy surrounding examples of political intervention in the affairs of public television suggests that the non-profit corporation as an attempt to insulate public broadcasting from government influence has imperfections.[74,75] Although privately owned information channels are also susceptible to governmental influence, especially when they are heavily subsidized, private ownership at least offers a last bastion against unrestrained government control. In addition to concern over governmental control and motives, the development of revenue sharing would seem to reflect increasing doubts about the ability of centralized government, if not government in general, to serve all the country's needs.

In view of these developments, it is useful to consider how a predominantly private enterprise operation can be made to work, even if the operation has to be propped up by the public sector. The strategies identified, good or bad, are not heretical to the "American Way." For the most part, they are drawn from past experiences having parallels to an educational telecommunications system in that they involved new technologies and industries, desirable from a societal standpoint, but having high commercial risks and capable of self-sufficiency only after the development stage.

It should also be reiterated that some of the development strategies discussed, such as REA-type financial assistance, user cooperatives, service demonstrations and user involvement are relevant regardless of whether control is public or private.

PART B

EXPLORING ISSUES AND OPTIONS AT THE COMPONENT LEVEL

1. Introduction

The first part of this memorandum dealt with several matters of concern in over-all systems design. PART B deals with each major component separately. Problems and issues of central concern to the planner of these components are discussed, and a number of alternative approaches for developing them are presented. In a later phase of the organizational design effort an attempt will be made to pull the component options discussed in this section of the memorandum into a few hypothetical educational telecommunications systems.

2. Program Sources -- Software

2.1 Needs and Problems

It is becoming ever more apparent that the success of an educational telecommunications system depends as much on the availability of ample supplies of high quality software as it does on the hardware. Shortage of quality program material has been repeatedly cited as a major factor in the failure of television and computer-assisted instruction (CAI) to make a significant impact on American education. Very little in the way of solutions has been offered, but a review of the small amount of literature concerned with software discloses a fairly solid consensus on the question of what the major obstacles to software development have been. Many of these obstacles would hold true for a nationwide telecommunications-based educational delivery system. They can be categorized under: Research and Development, Authoring and Production, and Marketing.

2.1.1 Research and Development

1. There is a tendency for the education industry to "think up" programs and then find customers for them rather than to develop software in accordance with expressed needs of educators and findings of basic learning research. [43]

2. There is a lack of any mechanism through which industry and educators can join together to systematically analyze the needs of education. Consequently industry is unsure of whether its products will be what educators want and need; and educators have little opportunity to influence the production decisions of industry. [76]

2.1.2 Authoring and Production

1. A need exists for qualified writing and production specialists familiar with the learning process as well as with television or computer program production techniques. [43]

2. Too little effort has been applied to organizing interdisciplinary teams of specialists to develop software, rather than relying on production specialists who know nothing about teaching specific disciplines or educators who know nothing of production capabilities and limitations. [77]

3. Educators involved in teaching need professional and economic incentives to participate in developing materials. [77]

2.1.3 Marketing

1. Market prospects for software are uncertain, making production a high risk undertaking.

2. Although the development of national instructional television program libraries (discussed later in this section) is encouraging, no organization of the scope needed currently exists to facilitate exchange of materials among widely dispersed sources and users. There is need for an arrangement that would encompass both CAI and television software from a diversity of sources -- commercial and public.

3. Due to the fractionated pattern of control among American educational systems, achieving the breadth of reach necessary to assemble a "critical mass" is expensive. This can make the cost of entering the software business too high in many cases. [52]

4. Incompatibility among software and hardware systems restricts the potential market for programs.

5. Failure to resolve copyright issues in a manner which will protect author incentives without inhibiting large-scale delivery of materials threatens the potential viability of the educational telecommunications system concept.

6. There is a need for designing the distribution system in such a way that prospective users, especially teachers, can preview materials, much as they now preview textbooks prior to incorporating them into curricula. [78]

It is not enough to think solely in terms of vast stores of educational materials. Because software is the most sensitive component when it comes to deciding who should be in control, it seems unlikely that it would be acceptable to have any single organization, governmental or private, dominate the production or distribution process. Therefore, it is necessary to plan measures which will

encourage support and development of materials by a diversity of sources. A competitive structure requires that program sources have easy access to the broadest possible audience and that users have knowledge of and access to the full range of sources.

2.2 The Roles of Industry and Government

In view of the problems and considerations which have been enumerated, we turn to some suggestions that have been made and then to some organizational alternatives for software development and distribution. Locke and Engler [76] have made the observation that industry, education and government have complementary roles in promoting software development and that coordination among these sectors is necessary to insure that each contributes in the area where its capabilities are greatest.

Industry, according to Locke and Engler, has little capability to do the basic learning research that has been a missing ingredient in the software development field to date. Basic research is best accomplished by members of the educational community. Currently, most educational and research institutions, including those working under Office of Education contracts, do not go beyond the prototype stage in developing educational materials. This is as it should be, according to Engler, [78] a vice president of McGraw-Hill. For its role, industry can make a major contribution with its special capacity for translating basic research findings and prototypes into marketable educational materials. Industry is better equipped to come up with "packaging" necessary to make educational materials effective. Some may question the need for slick packaging that can be offered by commercial enterprise, but there seems to be a trend toward replacing "cottage industry" productions with more professional materials. Businesses which in the past have produced personnel training materials "in-house" have found it necessary to turn to more professional software packaging in order to communicate with people who have become accustomed to the polish of commerical television. [79]

Locke and Engler, [76] both from the educational materials industry, comment that, in the absence of external influence from the educational community, industry is likely to put its efforts into developing materials that appear to have good sales potential but which may not be consonant with educational software needs that cannot be expressed in the marketplace. This is where government comes in.

Industry has to have both knowledge of educational needs and incentives to serve those needs. The suggestion made by Locke and Engler is that the national government finance, but not control, a "Commission on Research, Innovation and Evaluation". The commission would be composed of representatives from industry and education and would assess the needs of education. The organization could also be an agency through which educational system users would make contracts with industry for the production of materials. [76]

Such an arrangement obviously has some advantages for industry. It would give private organizations a better idea of what materials are needed by educators and thus reduce the uncertainty of producing materials on a more speculative basis. It would be a convenient way of giving users and sources a clear view of each other. The organization could work in two fundamentally different ways. In one case, the commission could be merely an advisory board, surveying users to discover their needs and giving industry guidance on the types of materials that would most likely be demanded. Its activities could be more extensive than that, however. The commission could be a coordinating agency to not only help facilitate contracts between industry and users, but also to fund users and to serve as a national administrative library. Such a library, as envisioned in the McMurrin report, [43] would not be a repository for materials. Instead, it would function as a cataloging agency, so that users would have a single organization through which they could learn of available resources nationwide. In addition, the "library" would identify and publicize those areas where there are shortages of software.

One ought to consider possible problems with such a commission. While it is intended that users would be free to choose sources as they please, the "advisory" function performed by the commission could result in an educational industry cartel-like system. With members of the industry cooperating so closely at the national level, vigilance would have to be maintained to insure that the cooperation would not manifest itself in market dividing, wherein one firm might tacitly agree to serve the market for CAI programs in languages, while another firm would handle the market for CAI programs in the physical science area. While such arrangements might hold advantages for the industry, it could result in less, not more diversity for users.

Government could perform functions other than financing the "Commission on Research, Innovation and Evaluation". The Office of Education has procedures which allow producers to become involved in the R and D phase of OE funded projects. Section 7 (c) of the OE copyright policy statement of 1970 allows OE contractors to bring producers into the R and D work, if the producer is selected on a competitive basis. As seen by OE, the advantages to such a procedure include the attraction of private capital, the availability of the producers' facilities and expertise, benefit of the producers' ability to foresee and avoid special problems regarding marketing and use of the product, and ease of transition from the development phase to the production and distribution phase.

Government must be careful, however, not to give any special advantage to a producer which might have an injurious effect on competition. The Office of Education's decision to place materials developed with OE funds under public domain arose from a situation in which OE funded the development of a physics textbook and collateral materials and then placed the Office's prestige behind the promotion of the book. The result was to put other physics texts at a competitive disadvantage and, at the same time, to preclude publishers from producing other versions of the government-supported text. [40]

2.3 Non-Commercial Sources

It should be assumed that private enterprise will have a significant role in software development but, by no means an exclusive role. Seidel [80] has even suggested that private enterprise is not an appropriate source for CAI software for university courses. Seidel reasons that a profit-making organization is without the motivation to engage in the continuous research and revision necessary to maintain the effectiveness of CAI materials. On the other hand, university faculties, who might be an alternative source, are without the time and incentives to develop and disseminate materials. What Seidel suggests is a non-profit organization created for the special purpose of developing CAI materials.

While there may be truth to Seidel's evaluation of the capabilities of educational institutions and private companies, a monolithic organization responsible for developing CAI materials seems neither wise nor probable. Lack of diversity is a condition to be avoided. It makes no difference whether domination is by a non-profit or commercial entity. As one of numerous sources, of course, a non-profit entity would no doubt be very useful. It is the concept of a single organization providing all CAI software that is bothersome.

The question of CAI software is an interesting one. If non-traditional education begins to unfold, a demand for commercially-produced CAI services seems inevitable. As for CAI in traditional classroom education, much attention is being given to teacher-created CAI programs. The reasons are partly cost and partly the ability of teacher involvement to lower teacher resistances to the introduction of CAI.

There are various ways the teacher can be included in the process of developing CAI software. One way is for the teacher to create a curriculum on paper and to then turn the paper over to a programmer who writes the actual program. The difficulty here is that the teacher may have little understanding of what makes for an effective CAI program, and the programmer may have little understanding of what the teacher is trying to accomplish. The result is that programs must be very simplistic, perhaps being written to accomplish no more than to tell the student, "right" or "wrong." More complicated student-machine dialogue is difficult to achieve under these circumstances.

Another method, used by the Hewlett-Packard CAI system, involves direct interaction between teacher and computer in the authoring process but without the teacher writing any programs. A general-purpose program is written to perform the function of prompting the teacher for answers that enable the computer to program itself. Still a third method of involving the teacher is to have the teachers write their own programs, using a simplified author language such as IBM's "coursewriter". [81]

Two large-scale CAI demonstrations are taking different approaches

to the acquisition of CAI materials. The PLATO project at University of Illinois uses the teacher-involvement rather than teacher-replacement approach. A comparatively simple author language (TUTOR) has been designed to enable teachers to write their own programs.

MITRE Corporation's TICCIT (time-shared interactive computer-controlled information television) project, on the other hand, involves self-contained packages of hardware, programs and collateral materials produced in collaboration with Brigham Young University. The production of the software involves an "industrial" approach, using teams of programmers, educational psychologists and subject matter specialists. [82]

The success or failure of these two approaches may tell us much about what sort of market will exist for commercially-produced CAI software.

2.4 Alternative Organizational Approaches to Software Development

Earlier in this report, references were made to various development strategies that might help to bring about a satellite-based telecommunications system for education. Most of these have relevance to encouraging software development, especially some of the financial incentives, service demonstrations and marketing assistance concepts. The intent here is not to repeat those, but to briefly identify a few administrative environments within which software development might take place.

2.4.1 Competitive Private Enterprise

If market prospects looked good enough, commercial producers might be counted upon to produce and distribute practically all the material needed to fuel the system. The primary advantage would be to remove the possibility of any government influence over this very sensitive component. A competitive industry would help to keep prices down to the minimum possible level. At present, no single firm appears to dominate the learning materials industry. But that may be due as much to the "thinness" of the market as to anything else. However, if the market blossoms, firms which are currently just "hanging around" to see what happens may move to corral as much of the market as possible.

A market, of course, has two sides -- buyers and sellers. The market picture envisioned here is one of many independent sellers and many independent buyers. A national "library" serving to identify, catalog and disseminate information about available software would be needed so that every system user would be able to readily find every source. At the same time, sources should know the identities of regular system users so that they can market their products on a nation-wide basis.

Sellers would probably develop group participation plans for certain types of materials where simultaneous mass distribution is required to make the programs economically viable. Distribution of television programs to CATV headends for real-time or delayed use in local markets would be an example.

The basic concept need not exclude indirect participation of government through user subsidies of one kind or another. To be fully competitive, the software component would have to be controlled separately from all other components. No supplier would be able to tie up any satellite or terrestrial channels through a full-time lease arrangement; and no ownership or operational control over satellite, storage, local/regional distribution or user institutions such as community learning centers would be allowed unless those components were controlled on a strictly non-discriminatory first-come basis. Any other arrangement would enable the integrated software source to block access by other sources or, at the very least, to offer lower prices due to lower distribution costs.

What is outlined here is a purely competitive model. Whatever system eventually develops may be controlled by a predominantly competitive private enterprise structure. But, more likely, it will be a blend of this and one or more of the other environments outlined below. But the basic approach of major participation by private enterprise under competitive conditions is something to strive for -- the primary advantages being the avoidance of government influence, low prices, continuous competition in the area of product improvement, and diversity.

2.4.2 User-funded, Non-profit Procurement Organization (Software purchased from private enterprise on a competitive basis)

It was mentioned earlier that one of the obstacles to development of ample supplies of software is the costliness of assembling a "critical mass" of users from a nationwide, fragmentarily controlled universe of users. Even with a national search/find library, the source must still sell each customer separately. For the small producer/distributor trying to break into the telecommunications-based education market, this obstacle could be decisive.

One possible way of overcoming the barrier is to retain the competitive supply side of the market but to consolidate users into one or more procurement organizations. Such an organization could be either a central programming authority, making all the program decisions for its constituency (e.g., a state educational authority), or a form of library. As a library the organization would be created by users as a non-profit entity, authorized to procure an inventory of materials from which constituent users could then select. Operating costs of the organization could be covered by flat membership fees or by a brokerage fee attached to each unit of software used. The attractive feature of this type of arrangement, near examples of which already exist in the form of instructional television libraries

discussed in section 2.5, is that it retains the virtues of a competitive supply system while at the same time reducing marketing and transaction costs for the suppliers by narrowing the number of contact points.

While either approach could conceivably range all the way from a single procurement agency for the whole nation to a more fragmented regional system, certain dangers emerge the more centralized the situation becomes. As the number of contact points is reduced, the chances for a source to sell another buyer if he fails with an earlier contact are reduced. Secondly, increased centralization might reduce the organization's responsiveness to constituents.

2.4.3 User-funded, Non-profit Production Organization

This is a turnabout from the competitive marketplace. The concept is similar to that proposed by Public Broadcasting Service (PBS) president, Hartford Gunn in his "Station Program Finance Plan" ("market plan") for public television mentioned in Section 4.4.3 of PART A. [63] Again, there could be one or more such organizations operating under the same concept. Although programming would be centralized, insulation from any government influence would be assured by retaining dollar power with individual constituents. Programming decisions would be made by money "votes" from users. When enough financial support developed to finance a proposed program it would be produced. The term can also refer to packages or series of CAI curricula.

While such an organization would not likely be acceptable as the sole source of educational materials, it might function well in conjunction with a predominantly competitive commercial system. It could even contract with commercial producers to have materials created. Supported mostly by user fees but also by outside assistance from foundations and perhaps government, the organization could serve to fill gaps left by the commercial market.

Perhaps the best opportunity for this type of organization would be at the regional level. Unique needs not met by commercial suppliers because of the limited market could be served by the non-profit organization. The means of support could be a formula combining membership fees to cover fixed overhead costs and program fees to pay a share of the cost of productions for which the user is a participating subscriber.

2.4.4 User-produced Software Shared Among Total Network Membership

Most of the plans that have been considered for library networks are based on this concept. That is, constituent libraries join together to expand each member library's resources. Similarly, this sort of organization for a satellite-based educational system, of which libraries would be members, would leave production to separate users, who might band together to form regional organizations. The national

organization would most closely resemble a composite of other networks. The system could be supplemented by one or more software production houses controlled by the network's central organization.

This kind of a system could operate in conjunction with the second alternative (user-funded procurement organization). A number of the user-funded organizations would obtain some materials from private producer/distributors and also produce some materials internally. The total resources of each organization would be made available to the entire network.

The virtue of this kind of an organization is that it builds upon existing infrastructure by interconnecting established components. Its main weakness is that some users would be more information-rich in resources than others. Those members with abundant resources would be called upon frequently to feed the network while some members would not be called upon at all but could burden contributors with requests. While it is likely that the program sources of the system will exhibit some characteristics of this kind of network, it does not seem probable that user-produced materials from a decentralized membership can be relied upon to completely fuel the system.

2.4.5 Combinations of Above

It would be naive to think that it is possible to draw up a plan describing what the precise structure of the software component will be. That depends on too many factors over which planners have minimal control. What can be done is to think in terms of what would be desirable and to then develop ideas for working toward that ideal.

It would seem reasonable to strive for a Program Source component that will protect the system from undue influence by a single entity and that will, as Toffler puts it, "hedge our educational bets" [65] by assuring a rich diversity of sources. To that end, competitive private enterprise should be promoted and should probably be expected to carry the heaviest burden. Within a predominantly private enterprise system, however, a number of other arrangements can co-exist, including the ones that have been mentioned. In addition, financial pump priming from government through user subsidies will probably be required. And policies to facilitate the transition from research to production and distribution, such as U.S.O.E.'s policy of allowing producers to be in on the R and D stage with contractors, will also be needed.

2.5 Existing Models for Software Marketing

It is true that no cohesive framework now exists to promote the development and marketing of software for all instructional media. However, the two national instructional television program libraries, (GPNITL and NIT) have enjoyed success in facilitating the exchange of existing ITV materials and, in the case of NIT, finding a unique approach to program development.

GPNITL (Great Plains National Instructional Television Library) was founded in 1962 at the University of Nebraska. [83] A study had revealed the existence of a large number of ITV programs produced by local school systems which were of high enough quality to become valuable resources for schools throughout the country. The library locates, acquires and distributes (by shipping) programming but does not produce any. As of 1972, more than one hundred "telecourses" were available through Great Plains. The library is equipped with numerous makes of videotape equipment, including videocassette machines [84], so that programs can be duplicated in a format compatible with the user's equipment. Programs are made available to schools and ETV stations on a lease basis, although some materials are available for sale. Sample lessons from ITV series are made available to users for previewing purposes, at no charge. Although initially funded by the Office of Education, Great Plains is now self-supporting through revenues from program leasing fees, part of which is paid to the program producers. In order to protect both the producer's financial rights and the economic viability of the library, restrictions are placed on the amount of "mileage" a user may get out of a program for the standard rental fee. Among the restrictions are the policy that the normal use period is seven days and a limitation on how many TV stations or ITFS headends which may be interconnected to receive a program. Income is also derived from the sale of study guides and other materials for use with the programs. Day-to-day operation of the library is handled by a full-time professional staff, but overall governance is by a Policy Board, which meets semi-annually and whose 18 members represent all sections of the country.

NIT (National Instructional Television Center) is located at Indiana University and has four regional offices. [85] The organization shares many things in common with GPNITL. Both are non-profit organizations supported through program leasing fees. In the case of NIT, rental prices are based on size of school enrollment. Like Great Plains, NIT identifies and distributes locally produced ITV programming. National advisory boards oversee both organizations, and other similarities exist. However, NIT also produces programs. Some production work involves adapting locally produced ITV programs for national use. To finance the development and production of new program series, NIT has taken the unique approach of organizing consortia to contribute both money and ideas. One of the biggest advantages to the consortium approach is the opportunity for flexibility. Different consortia can be organized for different program series so that the program development activities of NIT need not be confined to the interests of a single, fixed set of members.

Expanded to include media software other than television programming , the Great Plains and NIT approaches might hold promise for an educational telecommunications system. It should be pointed out, though, that neither organization functions as an educational "common carrier." Limited inventories are hand picked by the Great Plains and NIT staffs. So far, commercially produced software has not been included. The purpose of NIT and GPNITL has been to facilitate the sharing of existing user-produced programming rather than to provide a convenient marketing outlet for software producers. Both sharing and marketing outlet arrangements are needed.

The Office of Education's Bureau of Education for the Handicapped is making an effort to establish a system for disseminating instructional materials that may provide an even better model than the national ITV centers. A National Center on Educational Media and Materials for the Handicapped at Ohio State University has been authorized. In addition, a national "network" of fourteen Special Education Instructional Materials Centers (SEIMCs) and four Regional Media Centers for the Deaf (RMCs) has been established. [86] The system is still in a very early and loose stage of development, but it is hoped that the national and regional centers (all but two of which are located at universities) can be brought together into a functional whole. The system will have a four-point mission that includes:

1. Development of instructional materials for the handicapped.
2. Training people to use instructional resources.
3. Dissemination of information about education for the handicapped.
4. Devising an effective system for delivering instructional media materials to teachers and handicapped students.

The materials development portion of the mission entails:

1. Identifying needs.
2. Making needs known to both commercial and non-commercial producers and distributors.
3. Locating and disseminating information about usable materials, commercial and non-commercial.
4. Field testing materials.
5. Producing and distributing materials for which the market is too thin to attract commercial producers.

Although the SEIMC/RMC system is not a "network" in the sense of being interconnected, coordinators of the project envision eventual large scale use of telecommunications to deliver educational services to handicapped students.

3. Storage/Origination Points

In a very real sense, the sites which make up the storage component of an educational telecommunications system are tomorrow's "libraries." While use of these "libraries" or, more appropriately, "educational resource centers", will be accomplished electronically rather than by physical visitation, the organizational issues which arise in planning them are much the same as those which might be involved in planning a system of more conventional libraries:

1. Where should they be placed?
2. On what basis should responsibilities of storage centers be divided?
3. What means should be employed to select materials for the storage centers?
4. Who should control the storage centers?
5. Who should be permitted to retrieve materials from the centers?

The last question relates more to the system as a whole than to any single component, so our concern here is with the first four questions.

3.1 Placement of Facilities and Division of Responsibilities

Figures 5-8 illustrate alternative ways of assigning responsibilities to storage/origination centers. Traditionally, public libraries have divided responsibilities along geographic lines, each library serving as a general purpose facility for a geographically defined set of users, usually a community. One of the most significant characteristics of a satellite-based educational system is that storage centers would not necessarily have to be organized as general purpose facilities serving specific geographic areas (Figure 5). Since the user's access is electronic rather than physical, and the cost for the satellite portion of the delivery process is independent of distance, other organizational options exist.

Storage centers could be designed to serve users with common educational, ethnic, linguistic, or other indentifiable interests (Figure 6). Or they could be organized according to specific media specialties. As an example, national instructional television production houses could serve the ITV needs of users, as is the current arrangement with GPNITL and NIT, while CAI could be organized along either regional or specialty lines (Figure 7). A combined approach might involve a national layer of storage points organized according to subject specialty, feeding to regional layers of general purpose facilities (Figure 8). The flexibility afforded by satellite communications does not necessarily make placement irrelevant. While storage/origination points controlled along rigid geographic lines do impose limits on the diversity of materials a user can choose from (limits which, given satellites, are largely artificial), the regional approach does have one major redeeming advantage. If the users of a storage/origination center are confined to a limited geographic area around the center rather than scattered throughout the nation, their proximity to the center may enable them to exercise greater influence over the operators of the center. Only actual experience could tell whether or not proximity would be an important factor in determining operator responsiveness to users' needs.

The special purpose approach, while perhaps decreasing the user's opportunities to influence operator decisions, also offers advantages. First, materials acquired by one or a few national centers in each specialty can exploit economies of scale while, at the same time, offering a diversity of resources. If it were a matter of a national storage/origination point producing and distributing a single format for a given service (e.g., a national American History curriculum), that would be one thing. But the result could just as easily be more, not less diversity.

Operated as educational "common carriers", with non-discriminatory access for program suppliers, centers with access to the entire national audience could be an inducement to producers to develop materials for which a "critical mass" could not otherwise be assembled from the national market except by distributing through each regionally placed center. The high costs that necessitate a large volume of buyers are in the development and production of materials. So, the extra entry and storage costs of achieving national coverage by distributing a program

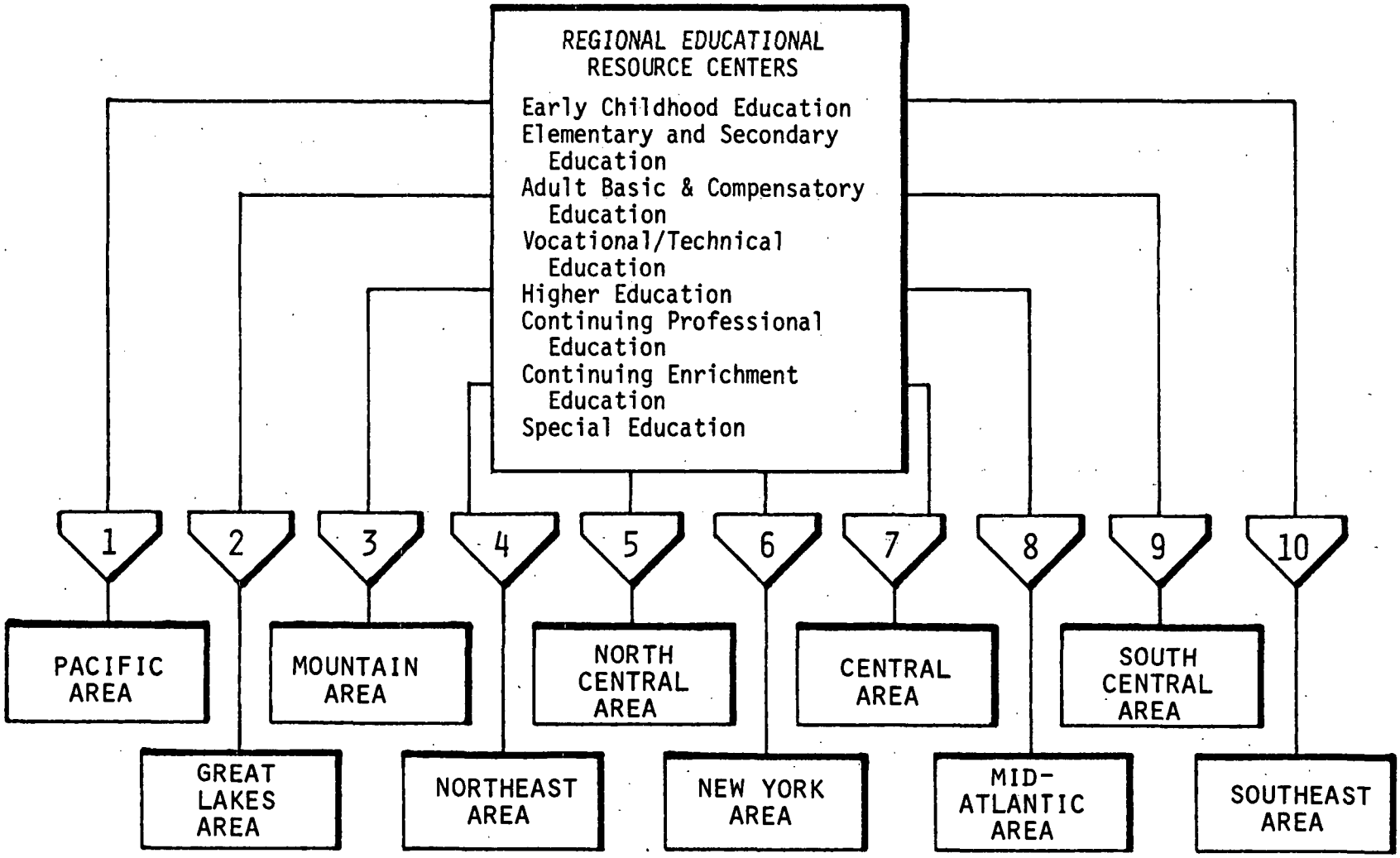

FIGURE 5

GENERAL PURPOSE EDUCATIONAL RESOURCE CENTERS WITH REGIONAL COVERAGE RESPONSIBILITIES

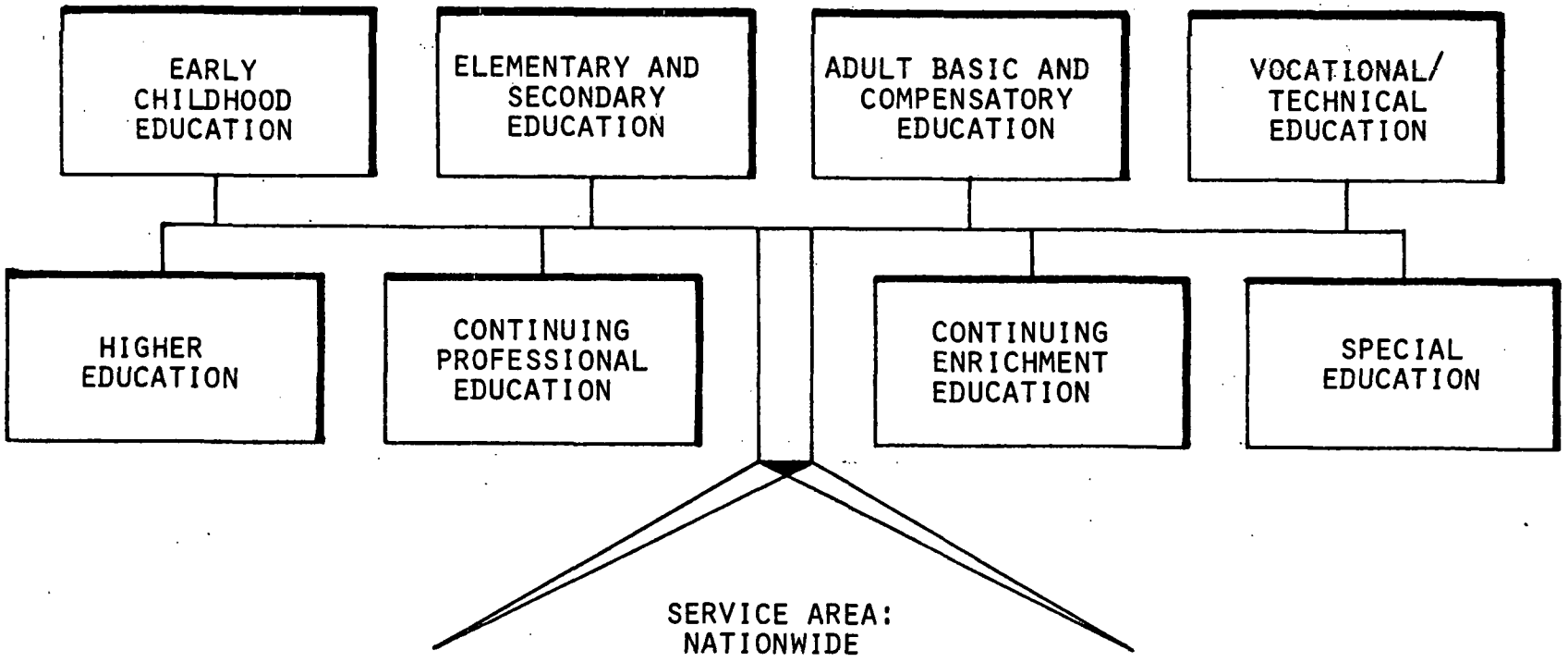

FIGURE 6

SPECIAL PURPOSE EDUCATIONAL RESOURCE CENTERS WITH NATIONWIDE COVERAGE RESPONSIBILITY

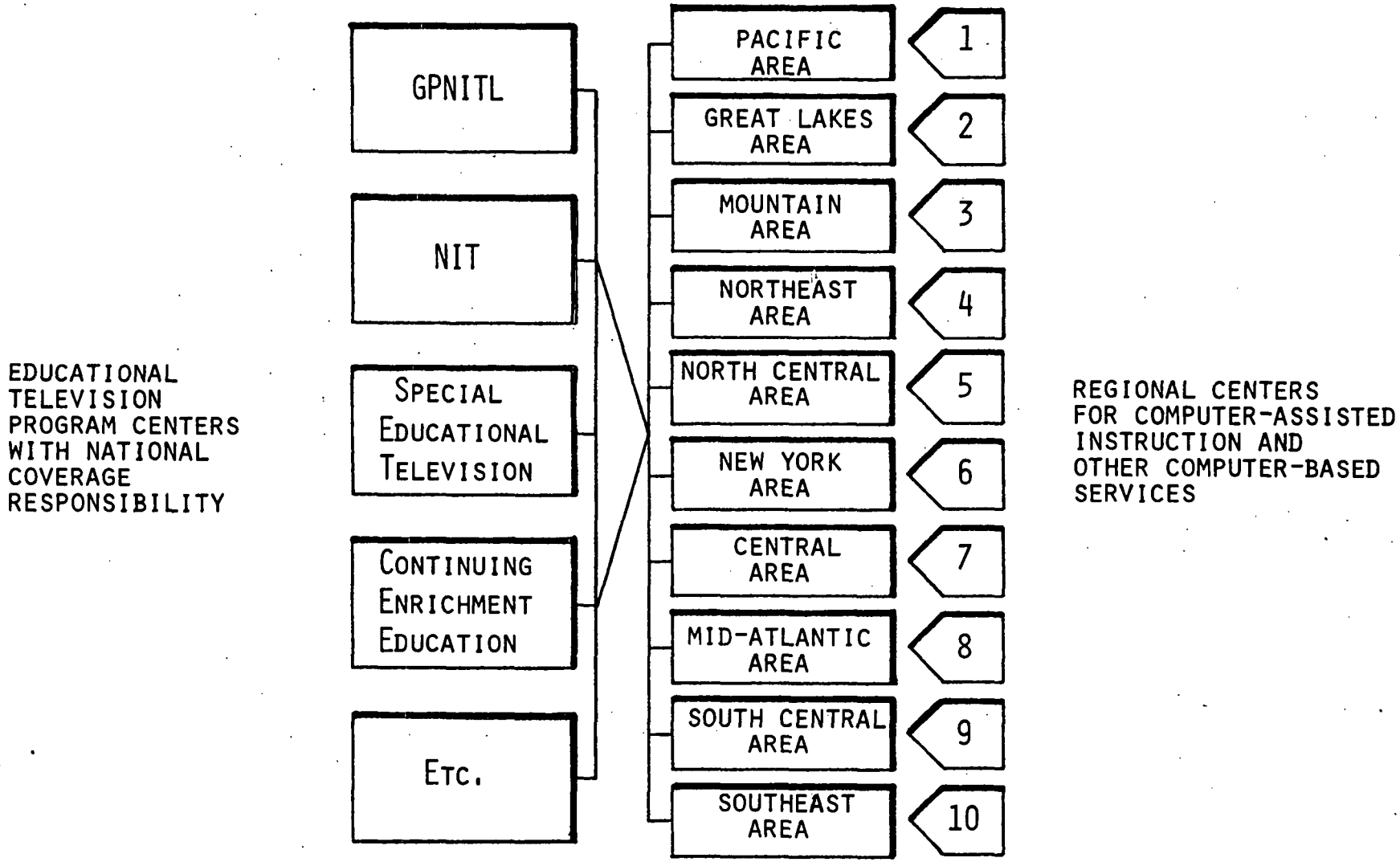

FIGURE 7

NATIONAL ETV CENTERS/REGIONAL CAI CENTERS

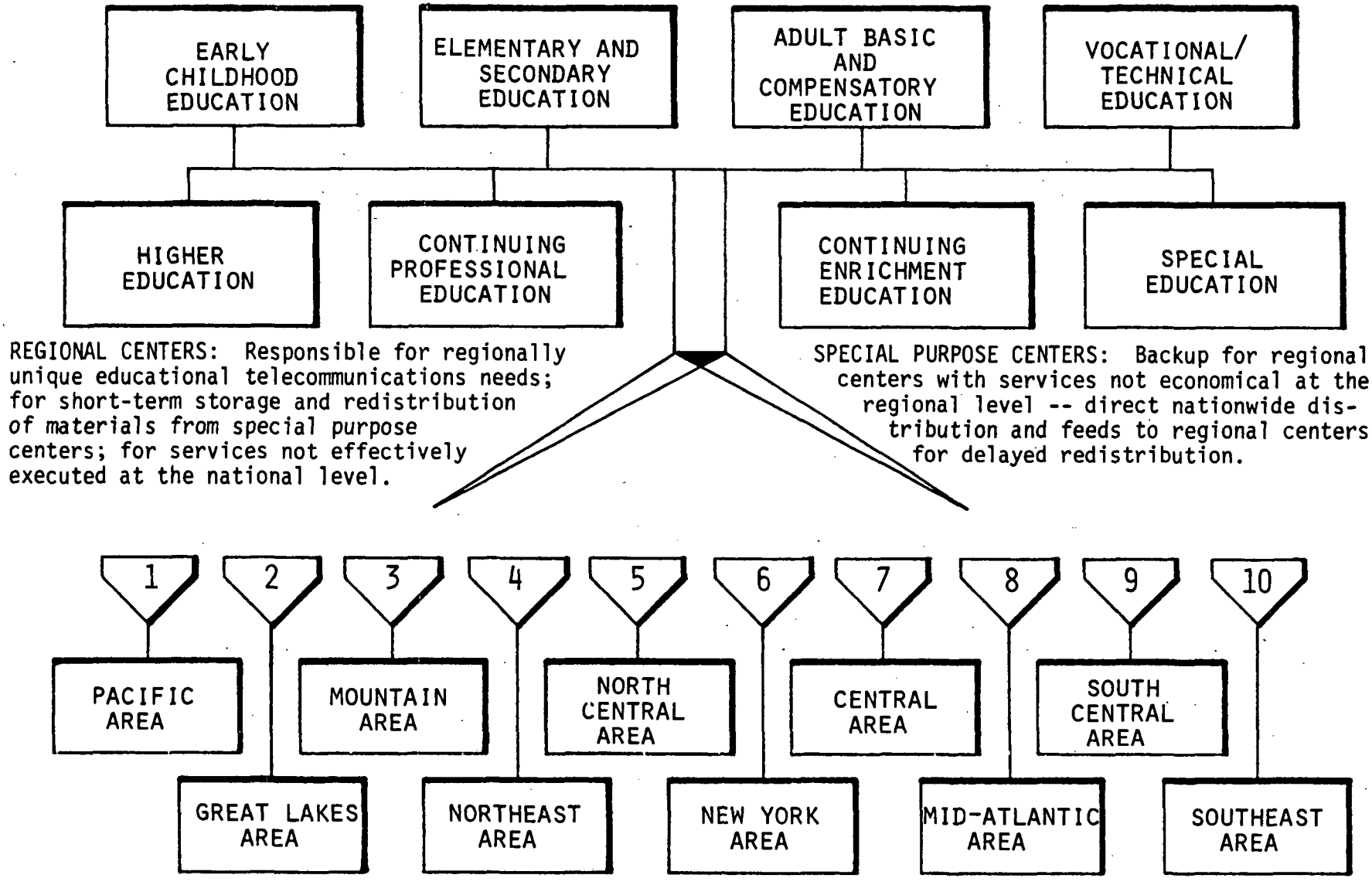

FIGURE 8

COMBINATION SPECIAL PURPOSE CENTERS WITH NATIONWIDE COVERAGE AND REGIONAL CENTERS

through ten regional centers instead of a single national center would probably be relatively small in comparison to the overall cost of the initial development and production. However, unless each regional facility were scaled to accommodate all the materials in the total national system, some selection and exclusion process would be necessary.

To illustrate the point, let us assume on the one hand a system (PLAN A in Table 2) of ten national storage centers, each serving a different educational specialty. Further assume that each one accomodates 25,000 units of software at any given time. Thus users have access to 250,000 units of software at any point in time, and the producer of each unit has access to the total national market.

On the other hand, assume ten regional, general purpose centers (PLAN B in Table 2), each responsible for serving the total needs of its constituent users. In order for users to have access to 250,000 units of software, ten 250,000 unit capacity centers must be constructed. Total national capacity would be increased tenfold to 2.5 million units. Yet the number of units available to any user would remain the same as in PLAN A -- 250,000.

If regional centers were scaled to accomodate something less than 250,000 units (perhaps 100,000), the diversity of material available to users would be decreased by 60 percent. Either fewer program sources would be able to form national markets through multi-regional distribution, or a larger number of sources would have to accept less than a total national market. (Table 2)

Although the regional model may afford users greater control over their respective storage centers than they would have in a system of specialized national centers, it is necessary to consider whether that additional control is worth the increased cost of large capacity regional centers offering duplicate services. On the other hand, even if the national system is both economically and organizationally sound, there still exists the possibility that such a centralized system would be unpopular. From the standpoint of political acceptability, less efficient configurations based on regional or even state boundaries may offer benefits that cannot be factored into any quantitative cost/benefit analysis.

Not much attention has been given to the opportunities for using satellites to deliver educational services to migratory populations. But an advantage to at least some nationally distributed services would seem to be that the services would be able to follow users from region to region. A more regionalized system might make instructional continuity difficult to achieve. The definition of migratory population need not be confined to farm labor groups. In an increasingly mobile society, the label can apply to just about anyone.

TABLE 2

IMPACT OF REGIONAL GENERAL PURPOSE CENTERS ON SOFTWARE DIVERSITY AND DISTRIBUTOR COVERAGE

	PLAN A 10 Special Purpose Centers Each with National Coverage	PLAN B 10 General Purpose Centers Each with Regional Coverage
SOFTWARE ITEMS PER CENTER:	25,000	Option (1) 25,000 (2) 100,000 (3) 250,000
TOTAL NATIONAL INVENTORY	250,000	Option (1) 250,000 (2) 1,000,000 (3) 2,500,000
TOTAL ITEMS WITH ACCESS TO ENTIRE NATIONAL MARKET, ASSUMING PLAN B INVOLVES STORAGE OF EVERY ITEM AT ALL REGIONAL CENTERS:	250,000 NATIONAL CAPACITY REQUIRED TO GIVE AN EQUIVALENT INVENTORY NATIONAL COVERAGE IN PLAN B**	Option (1) 25,000 (2) 100,000 (3) 250,000
	** If this capacity is not provided, and every item entered into the system is automatically duplicated at every regional center, then fewer items will have access to the system than in PLAN A. Alternatively, an equal number of items could have access to the system, but could not achieve national coverage.	
PERCENT OF NATIONAL MARKET AVAILABLE TO EACH UNDUPLICATED ITEM:	100%	10%
TOTAL INVENTORY AVAILABLE TO EACH USER:	250,000	Option (1) 25,000 (2) 100,000 (3) 250,000

3.2 Selection of Materials

Section 2.4 of PART A discussed consent as one important ingredient of access. Permission to gain entry to the distribution system through each component "gateway", including storage, is as important for program sources as it is for users. The various methods of selection discussed earlier, in general terms, merits brief recapitulation in the present discussion of the storage/origination component. Major alternatives include:

1. Prepare for all comers. . .
   Give storage points large enough capacity and adaptability to accommodate all software distributors who might choose to market products through the system. In this way the only selection authority would be that exercised by users with their willingness to pay for the materials that would be made available by software producers.

In considering this approach, it should be kept in mind that a potentially important tradeoff between user interests and distributor access is involved,as is depicted in Figure 9. If it is desirable to minimize cost as an obstacle to user access to the system, then maximizing distributor access to the system could be counter-productive. For example, if storage facilities are sized to accommodate all potential suppliers, and if expenditures are made for conversion equipment that will enable otherwise incompatible software to be delivered by means of the satellite-based system, then the extra cost of doing these things will make it necessary to increase the user's cost of retrieving the materials.

As an illustration, if equipment were to be installed for converting 1/2-inch videotape or 8mm film to system standards geared to high-band 2-inch tape and 16mm film, then the cost would have to be distributed among users, including those who never request any of the materials which require conversion. In effect, these users and the distributors of software produced to system standards would end up subsidizing the maverick-standard suppliers. The economist's answer to this might be that the storage fee structure be designed so that each supplier's fee would reflect the real cost of accommodating his product. In other words, 8mm film and 1/2-inch videotape suppliers would pay more.

But that solution is too simple. It ignores the basic issue. The producers of the maverick-standard software would likely produce to that standard because of the low cost of doing so. They would probably be organizations or individuals who could not produce materials if they had to use 2-inch videotape. Requiring the higher standards would preclude participation by these producers in the national distribution system, restricting the producers to more localized entry modes and coverage, such as cable television.

The argument can be made that this is not a real issue, because producers of such materials as "underground video" would not really be interested in displaying materials nationally by means of a large-scale satellite delivery system. But how can we be sure? By locking them out

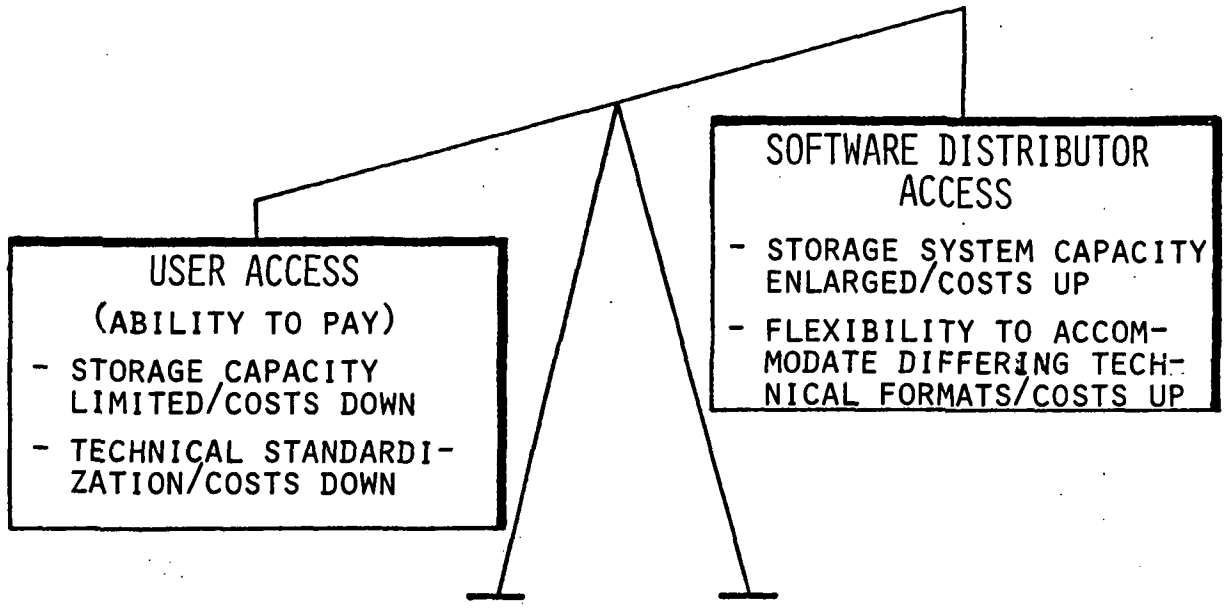

FIGURE 9

USER-DISTRIBUTOR ACCESS TRADEOFF

of the system under the guise of maintaining the system's technical integrity, are we not also excluding the expression of certain values and life styles?

2. Dual-status entry, based on usage. . .

Two modes of storage might be planned. Under this approach, a center would catalog but not physically store rarely used materials. If a user wished to receive any of those materials through the system, he could do so; but some delay would be involved in locating the requested software and loading it into the facility. The system would be sized to"permanently" accommodate materials obtaining a designated usage level. A certain amount of extra capacity would be planned to temporarily store and process occasionally used materials. Whenever use of materials in the "permanent" storage mode fell below a certain level, those materials would be removed to the temporary mode along with other occasionally used materials. This would make room for introduction of fresh materials. This approach has appeal as a workable compromise between the diseconomies of sizing the system for all possible distributors and more exclusionary methods.

3. Limited capacity available on a first come basis. . .

Storage facility capacity could be fixed at an acceptable level, but somewhat below anticipated demand. Access for distributors could then be on a non-discriminatory first come basis. This common carrier approach,combined with limited capacity, may have more merit

for the transmission component where occupancy would be transitory; that is, unless channels were leased on a full-time basis. But at the storage point, first come-first serve could amount to "squatter's rights", depending on the turnover rate.

4. Mixed system. . .
A mixed approach, wherein some capacity would be reserved for materials serving certain priority needs and the remaining capacity would be filled on a non-discriminatory access basis, might be the most effective plan.

3.3 Control

Numerous possibilities exist for control of the storage centers. A national system of special purpose centers could be patterned after the Educational Research Information Center (ERIC) system, with the over-all system coordinated by the Office of Education but with the separate centers run by independent contractors. [87] Each center would be responsible for acquiring and processing a specialized subset of educational software. Adaptation of the ERIC model to a system of storage centers would probably require that the ownership/management functions be separated from the programming function, in order to avoid national governmental control. This model could assure that the system would have coherence and still maintain a significant amount of autonomy from the national government.

For a network of storage centers organized along regional, rather than special purpose lines, such multi-state, multi-institutional user organizations as the Federation of Rocky Mountain States, Appalachian Regional Commission, or the Western Interstate Commission on Higher Education could be appropriate models. Integration of ownership and programming might be less objectionable, even desirable, under these circumstances. The organizations could identify their needs and then produce or procure the programming required to serve those needs. It would be very important to have representation of such user categories as public broadcasting stations, cablecasting networks, proprietary educational services and special audience groups in governance of such centers.

The Regional Educational Laboratories, authorized by Title IV of the 1965 Elementary and Secondary Education Act,provide yet another model for regionally organized general purpose centers. Although funded by the National Institute of Education, the RELs are organized as independent, non-profit corporations, each with its own management and governing board. The governing board is typically a mix of representatives from education, business, and other interests. [88]

It should not be expected that the RELs themselves would be appropriate managers of storage centers for the educational telecommunications system. They are designed to serve elementary and secondary schools in their respective regions by helping the schools to adapt research findings and innovations for practical use in schools. But the basic organizational framework within which they operate

(i.e., federally funded but regionally controlled by a cross section of community interests) may be a promising model.

Still another possibility for either national special purpose or regional general purpose storage centers would be program distributor controlled centers. In effect, distributors would cooperatively own and operate the centers. The rationale for this sort of arrangement would be to give distributors a stronger voice in the management of the system and, thereby, a means of insuring that the system is tailored to meet their requirements. There would be an opportunity here for participating distributors to establish policies to restrict competition. In any event, distributor owned storage centers would not likely materialize from thin air. Considerable spurring from the public sector would no doubt be required to bring them into being.

The foregoing comments do not exhaust the alternatives, because it is possible that no single system will provide the full storage capacity of the educational telecommunications system. A national system of special purpose centers, for example, might only be a foundation upon which a more intricate and varied complex of storage/origination points and regional networks would be constructed.

The national centers, collectively, would form the source end of a centralized network, in which the information flow would be from a central node to many regional distribution systems. Many software distributors could bicycle their products to the national centers for storage, since input timing would often not be critical. Time would more likely be a critical factor for users wishing to retrieve already stored materials. Even so, the centralized structure would not be suitable for all uses of the telecommunications system. For example, political realities and economic considerations may require that each state have an originating capability, with an uplink to the satellite to allow satellite usage for intrastate distribution. This may be especially true for the thinly populated states, where the economic advantages of distribution via satellite would be most pronounced. PBS, as another example, has anticipated a need for the capability to originate programs for both national and sub-national distribution from 28 points throughout the country. [89] Because of limitations on the number of student terminals that can be efficiently served by a single computer, CAI also might best be distributed through a layer of regional centers. CAI programs could be stored at national centers and distributed to regional points. But the actual dialog would be between students and regionally placed computers. Certain geographically unique materials might also best be distributed by regional centers.

In a system of national special purpose centers supplemented by a layer of regional general purpose centers, the regional centers would serve the dual functions of being the central nodes in regional newtworks and being the redistribution points for the national system. To accommodate diversity, the pattern of ownership and control could vary from region to region, state to state. That a number of comprehensive educational service centers will be in place in some states by the time an educational satellite system is inaugurated seems likely.

The "Comprehensive Development Plan" (CODE) of the State University System of Florida, [90] which calls for consolidated media facilities, and the Stone Report ("A Prospectus for Educational Resources Access") in California, [91] calling for statewide coordination in ITV and computer services, might be considered indications that thought along these lines is already growing.

In thinking about regional organizations, the structure of formal eudcation in this country should be kept in mind. Legal responsibility for schools belongs to the states. For this reason, regional educational organizations should not maintain direct liaison with individual local school systems. Instead, the liaison should be with state education agencies or special state educational telecommunications authorities. The importance of integrating state authorities into the organizational structure goes beyond mere etiquette. Accrediting programs of instruction and certifying some professionals are state functions. Coordination between states and regional or national organizations offering telecommunications-based instruction is therefore essential.

It is the author's opinion that a nationwide educational telecommunications system cannot expect to succeed if its implementation depends on supplanting rather than building upon existing arrangements. This is not to say structures will not change as the result of a comprehensive telecommunications system. They will, but the process will be gradual, not like a bulldozer.

3.4 A Call for Action: The Carnegie Commission Report

No discussion of storage/origination points would be current without mention of the recent Carnegie Commission on Higher Education report, calling for the establishment by institutions of higher learning of seven regionally organized cooperative learning centers. [92] The recommendation was made as part of the report's primary theme, which was a strong endorsement for the use of technology in higher education.

Although the centers would engage in research and development, their primary functions would be the identification, production and distribution of learning materials. The commission recommended that seven cities* be the focal points for the centers, but noted that services coordinated by each center could be originated from more than one location. Although initial services would be only for institutions of higher education, ultimately materials could be distributed to public schools, libraries etc. The commission recommended that the federal government pay all the initial capital expenses ($35 million per center) and one third of annual operating expenses ($150 million per center -- government share: $50 million).

The approach is similar to the user cooperative mode of control mentioned earlier. Apparently software would be a combination of center-produced materials as well as materials contributed by participating institutions.

* San Francisco, Denver, Houston, Atlanta, Chicago, Philadelphia, Boston.

The report is important especially because a leader in the higher educational community has given its support to a software sharing concept that is national in scope. The specifics of the proposal would no doubt be given thorough analysis before being implemented. Particularly in need of scrutiny would be the small number of centers proposed; the wisdom of having a network of resource centers devoted solely to higher education; the commission's emphasis on user- and center-produced materials, to the apparent exclusion of commercial software; and the heavy reliance on federal funding that was proposed.

4. Transmission

In discussing the transmission component, the concern is with two separately identifiable but interdependent segments; (1) satellites and (2) earth terminals (both downlink receivers and receive/transmit stations). Alternatives for the transmission component revolve about questions pertaining to dedicated versus non-dedicated systems, integrated control of the satellite and earth segments, and optimal balancing of economic tradeoffs between high-power satellite/low-cost ground terminal configurations and low-power satellite/high-cost ground terminal configurations.

4.1 Dedicated versus Non-Dedicated Systems

Singh et. al. [4] have spelled out three basic alternatives for the satellite segment. One choice would be to utilize channel capacity from the commercial domestic satellite systems ("domsats") which have been proposed. The earth segment would be a combination of commercial terminals and separately owned stations placed especially to serve educational needs. A second alternative would be to deploy a dedicated satellite system; that is, one configured specifically to meet educational requirements. It is generally agreed this would require high-power satellites working in conjunction with thousands of low-cost earth terminals colocated with ultimate dissemination points, which would eliminate the need for costly terrestrial microwave "tails." To achieve this requires selection of operating frequencies that will not interfere with communications services, especially in urban areas where the traffic on the radio spectrum is severely congested. A third alternative would be a "hybrid" system, utilizing a combination of the proposed commercial systems and separately owned dedicated satellites. The "domsats" would be used to interconnect points common to both commercial and educational services. CATV interconnection would be an example. Dedicated satellites would serve points where commercial and educational interests do not converge. While the relative merits of these alternatives have been considered in the report cited above and elsewhere, it is probably useful to outline the key points here.

4.1.1 Using Commercial "Domsats"

Perhaps the strongest argument in favor of relying on the proposed commercial domestic satellites is that lack of public support for a separate dedicated satellite system may require it. As stated in the

report mentioned above, the commercial satellite proposals under consideration share three crucial deficiencies where educational needs are concerned: "(1) low-power transponders necessitating use of costly earth terminals; (2) use of 4 and 6 GHz frequency bands, which severely restricts the colocation of the earth terminals with urban operation and/or redistribution centers; and (3) relatively few receive/transmit earth stations are planned which complicates the problem of access." [4] With the notable exception of cable television, overlap between educational and commercial satellite requirements appears minimal.

In its Report and Order in Docket 16495 adopted March 20, 1970, the Federal Communications Commission declared that applicants proposing multipurpose domestic communication satellite systems should discuss terms and conditions under which satellite service would be made available to educational users. Four of the eight applicants (MCI-Lockheed, Fairchild-Hiller, Hughes Aircraft, RCA Global/Alaska Communications) spelled out proposed public service offerings. Only MCI-Lockheed considered educational uses other than public and instructional television distribution.

Since the initial applications were filed, joint ventures have been proposed between Comsat and MCI-Lockheed and between Fairchild Industries and Western Union International (under the name American Satellite Corporation). These corporate realignments, together with the commission's firm decision not to enunciate any policy statement regarding public service offerings or to require an early filing of rate proposals (Memorandum Opinion and Order in Docket 16495 adopted December 21, 1972) leave the prospects of preferential treatment for educational users very uncertain.

4.1.2 A Dedicated Satellite System

The concept of a separate, dedicated satellite system is exciting. Its economic viability, however, is questionable for projected near-term demand, even given the already stated requirements of public television and radio. When completed, the systems synthesis work now underway at Washington University should provide more exact information about this than is currently available. On the other hand, it is also questionable whether demand can blossom without the inspiration of a satellite system waiting to be used. There is ample precedent for public underwriting of important new ventures ahead of demand, as we attempted to illustrate in section 6 of PART A.

4.1.3 A Hybrid System

The "hybrid" approach seems reasonable enough in principle. Why duplicate available commercial services? There is special merit in relying on commercial satellite channels to disseminate services to CATV headends. And cablecasting could prove to be the real workhorse for the educational telecommunications system, if enough channels are available. If a dedicated satellite system were to be used, a CATV headend operator would have to install a special terminal to receive educational services.

Unless the operators were willing to provide the terminal, either the dedicated satellite system or local users would have to pay the bill. Using Quantum Science Corporation's forecast of 4200 as the number of CATV systems in 1982, [93] and $15,000 - 100,000 as a range for the cost of a reception station, the ground terminal investment for CATV interconnection could amount to an aggregate investment of from $63 - 420 million, in addition to the cost of separate terminals for reception of signals from non-dedicated "domsats."

One thing that should be considered is that, if the "hybrid" approach were to be used, the organization controlling the dedicated system would almost certainly have to be publicly-supported. The non-dedicated commercial satellites would have siphoned off the economically most viable portion of the educational market. If there is any desire to have a dedicated system that would be privately owned and free of public purse-strings, initiatives would need to be taken to insure that the dedicated system operator is not left with only the non-lucrative portion of the education market. Just as the commercial television network market will be a windfall for the "domsat" operator who ends up serving it, distribution of educational services to CATV headends and public television and radio interconnection are likely to be "musts" for the private educational satellite operator.

4.2 Optimizing the Satellite-Earth Terminal Tradeoff

As illustrated in Figure 10, it becomes more attractive cost-wise to invest in larger satellite power output and lower-cost ground terminals as the terminal population increases. The question before us, then, is whether or not it would be wise to invest in more costly high-power satellites in the early stages of development when the number of points served may be relatively small. If demand or terminal population during the life of the first satellites deployed is projected to be small, then least-cost analysis would lead one to conclude that more expensive high-performance ground terminals should be used in conjunction with low-power satellites.

If the space and ground segments are to be under the integrated ownership of either government or a business firm, then the least-cost approach makes sense. If, on the other hand, control of the earth terminals is to be separate from control of the space segment, the least-cost approach could retard system growth. A system optimized on the basis of earth terminals costing $100,000 rather than $20,000 could discourage participation if users are expected to buy, or even lease, their own terminals. Most certainly, those who would be discouraged first would be less affluent potential users. An innovation justified partly on its ability to equalize access to educational services, as satellites have been, would be ill-conceived if it were to have the opposite effect. It would be possible, of course, to go the least-cost route and to subsidize users in the procurement of earth terminals. But one should not overlook the fact that any such subsidy program involves administrative costs. The need to go through more "red tape" to obtain subsidies could, in itself, be a deterrent to participation.

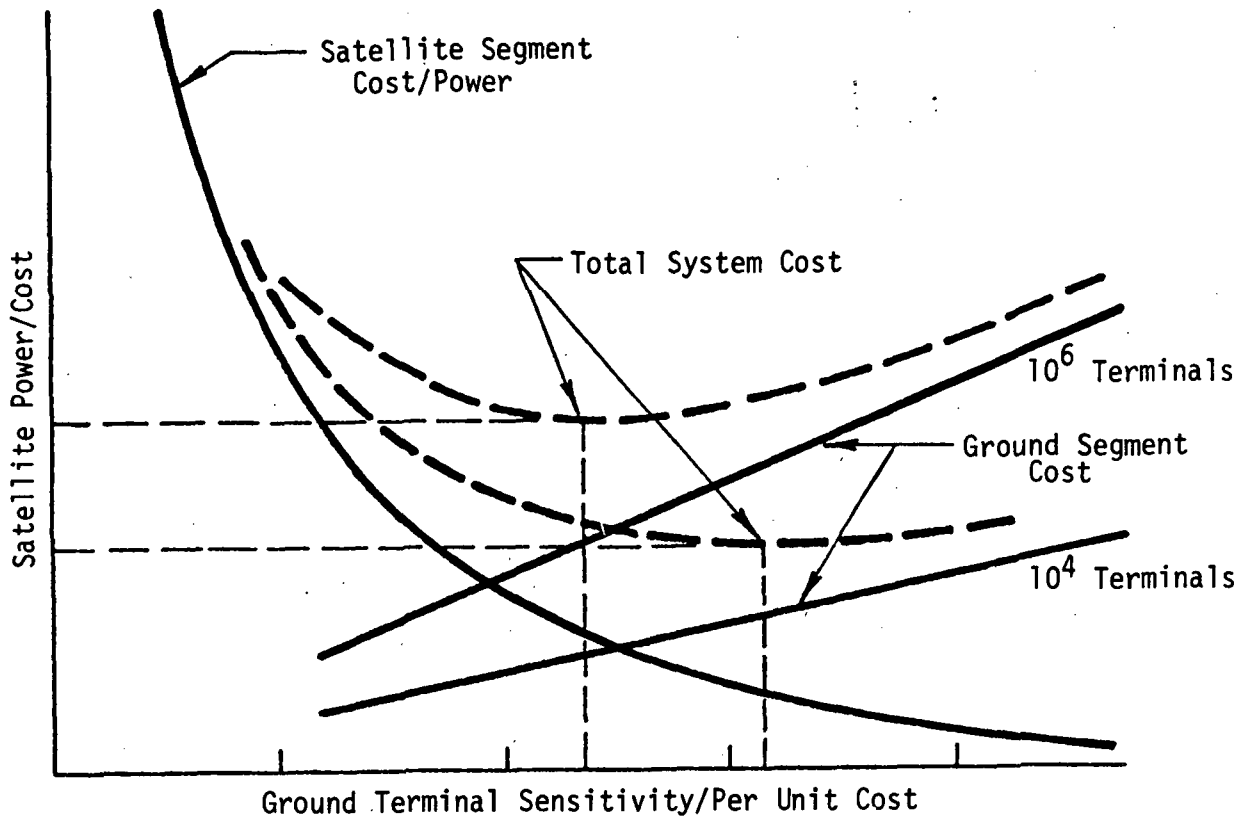

FIGURE 10

ILLUSTRATION OF
SATELLITE POWER/GROUND TERMINAL SENSITIVITY TRADEOFF

Figure 10 depicts the tradeoff between ground terminal sensitivity/cost and satellite transmission power/cost. TOTAL SYSTEM COST = SATELLITE COST + (GROUND TERMINAL UNIT COST x NUMBER OF TERMINALS). Therefore, as the ground terminal population grows from ten thousand to one million, achieving minimum cost increasingly depends on reducing the unit cost of ground terminals by using less sensitive terminals in conjunction with greater satellite transmission power.

4.3 Administrative Options

In addition to the question of dedicated versus non-dedicated satellites, there are several alternative modes of control over the satellite segment which are briefly enumerated below.

4.3.1 Non-profit Corporation Model

This is the approach that has been mentioned most frequently in connection with ownership of the satellites in a dedicated system. Within the basic framework, two options would be available.

1. Separation of owner/operator function from programming.
DuMolin and Morgan have suggested this approach for the AVSIN system. AVSIN would be a non-profit satellite operator and would control the earth terminals. The satellite system would operate as a common carrier, with program material supplied in the competitive marketplace and program selection accomplished by users on an independent access basis.

2. Integration of owner/operator/programming functions.
In this kind of system, which is similar to public television as currently structured or the envisioned Hughes system, the satellite operator would not be a common carrier. Programming would be procured on a contract basis or produced by the organization itself. The operator would schedule programs rather than offer them on an independent access basis. Programs would be repeated in order to serve user convenience.

4.3.2 Government Corporation (TVA Model)

A government corporation could operate in essentially the same manner as the non-integrated corporation described above (option 1), or a new concept could be introduced. The new approach would be to lease channels or blocks of channels to independent earth terminal operators, much as TVA sells bulk power on a wholesale basis to electric cooperatives for retail distribution. Earth terminal operators serving different regions of the country could lease channels on a full-time basis to provide communications services in their respective coverage areas. Cooperative arrangements among the regional common carriers would have to be established to facilitate inter-regional exchanges, or a certain amount of channel capacity for inter-regional communications might be retained by the government corporation. Widely dispersed groups with common educational needs might also lease channels on a full-time basis.

4.3.3 Government Agency Model

The government might pay the cost of building the system and authorize a designated agency to grant a franchise to a private operator. Although the franchise agreement might specify a number of different kinds of arrangements, the one envisioned here is a common carrier

type of operation, with independent access by users.

4.3.4 Turnkey Model

The approach here is the same as that described in section 6.5 of PART A, under "development strategies". Government would build the system and operate it for a limited period of time (until ground terminal population reached a high enough level to make operation of the system economically attractive to a private entity). The system would then be sold by the government.

4.3.5 Private Corporation, Common Carrier Model

A private, for profit corporation would own and operate the system. The corporation would not be permitted to supply any of the programming. A public agency would have to regulate the corporation to insure that unattractive as well as lucrative markets would be served. A modified and somewhat more probable version of the private, for profit model might be a satellite interconnection system owned and operated by a consortium of cable companies. A satellite interconnected cable network would fall short of the full potentials of educational telecommunications networking. But it could be a logical step in the evolution of a privately-owned, multi-purpose system that would be customized for all users whose networking requirements, like those of education, call for high-power satellites and low-cost receivers.

4.4 Additional Remarks on Administrative Options

It is not necessary to again argue the relative merits and shortcomings of government versus private enterprise versus non-profit modes of control. Perhaps it would be useful, though, to emphasize a couple of points about some of the features which have been mentioned in connection with these five alternatives.

4.4.1 Repetitive Scheduling vs. Demand Access

The repetitive scheduling that was mentioned for option no. 2 under non-profit corporations (page 84) could be incorporated into almost any system. It is an alternative to user signaling for access to programming material. Farquhar [94] has pointed out that independent access capability requires fairly sophisticated switching facilities at the distribution center. Continuous programming, on the other hand, requires less sophisticated head-end switching but greater distribution system capacity. The educational telecommunications system which finally evolves will no doubt utilize a mix of operator-scheduled distribution, repetitive operator scheduling, demand access services, and delayed feeds.

4.4.2 TVA Model - Wholesale Distribution

If technically feasible, wholesale leasing of channels to terrestrial carriers, user groups or program distributors offers three potential advantages. First, such arrangements could have the effect of diffusing control over the satellite segment without requiring each operator to duplicate the high fixed costs that would be involved if several operators made the unlikely decision to deploy small capacity satellites to serve educational users. This could go a long way toward allaying fears, warranted or not, about the "big brother" aspects of a national educational telecommunications network. Secondly, the wholesale leasing plan would permit a program distributor, for example, to obtain the advantages of vertical integration (i.e., guaranteed channel capacity with accompanying low transaction costs) without the public having to tolerate another gargantuan national monopoly. Third, relatively small budget organizations would be able to have quasi-proprietary control over satellite capacity, which would be possible only for the corporate giant if ownership of a whole satellite were required.

4.4.3 Government Franchising

For a private investor, the high financial risk involved is probably a serious deterrent to the construction of a dedicated satellite system. Operating costs, however, may not be such a strong deterrent. Government ownership combined with operation by a private franchise would lift the financial barrier to proprietary control. By making the franchise agreement subject to periodic review, the benefits of private operation could be obtained without totally relinquishing public control. A periodic review of overall performance would perhaps give the operator more leeway and, consequently, give the public better service than would a scheme of regulating day-to-day operations by a hard-and-fast set of rules.

4.5 Non-Integrated Control of Earth Terminals

Earlier in this memorandum, it was suggested that integrated control of satellite with receive/transmit stations and the more expensive reception terminals located at midway distribution points might have certain advantages. Control of these terminals would guarantee the satellite operator at least a basic core terrestrial network through which to pipe transmissions.

In thin market areas, where a profit-seeking corporation might not find it feasible to place terminals, other ownership mechanisms such as community utilities or user-owned cooperatives analagous to the REA approach may be required. Although the lower cost receive terminals could be inexpensive enough to be owned by individual users, the cooperative approach may have some utility even here. Ownership of the terminals by regional organizations, for example, could enable the organizations to promote utilization of the educational satellite system, using possession of the terminals and proximity to their clientele

as leverage. At the same time, the organizations could provide the maintenance capabilities of large organizations while avoiding the potential disadvantages of highly centralized control by the satellite operator as envisioned by DuMolin. [8]

5. Local-Regional Distribution

5.1 Introduction

It is tempting to think about alternative configurations for an educational telecommunications system mainly in terms of satellite-ground terminal tradeoffs and to put local and regional distribution systems, important as they are, on a back burner.

The primary function of satellites can be described as long-haul information transfer. Once a service has been carried to a reception terminal in the general vicinity of use, other communications channels will frequently have to be relied upon to deliver the service to its ultimate consumption points. As the terminal population approaches saturation, satellite delivery points and ultimate consumption points will be increasingly colocated. But in the developmental stage, this may not be the case. Some of the non-traditional educational services that have been talked about among educators are likely to be most appropriate for household consumption rather than for larger institutional settings such as schools, hospitals, prisons, businesses, libraries and community centers. Certainly early childhood education for joint parent-child reception would fall into this category. Adult "enrichment" education and any non-interactive educational service might also be appropriate for home delivery. This is not to necessarily preclude eventual home-based interactive services, but it seems reasonable to say that such capability on a pervasive scale will be a while in coming.

There is a need to consider not only what means will be used to deliver services from reception terminal to ultimate consumption point but also those systems which will be used to deliver reverse feeds for sub-national program origination, interactive services such as CAI and information retrieval. A wide array of technologies are currently available. The media vary in the amount of territory they are normally intended to serve. Here, they will be categorized as Regional, Regional and Local, Local, and Intramural:

REGIONAL

--Specialized common carrier microwave -- Data Transmission Corporation (DATRAN), Microwave Communications Inc. (MCI), etc.

--General purpose interstate microwave -- AT&T

REGIONAL AND LOCAL

--Telephone lines

--FM Subsidiary Communications Authorization (SCA)

--Open-circuit television and radio

LOCAL

--CATV

--Instructional Television Fixed Service (ITFS) 2500 MHz

--Multipoint Distribution Service (MDS) 2150-2160 MHz

INTRAMURAL

--Closed-circuit television (CCTV)

With the exception of ITFS and CCTV, use of the media listed above by the educational telecommunications system would likely be on a shared basis with other users, commercial and non-commercial. A major exception to this generalization can be found in at least ten states which own the microwave interconnection systems for their educational television networks. [95]

5.2 Dedicated and Educator-Owned Cable

The Barnett and Denzau study [5,6] illustrated that, from an economic standpoint, a dedicated 40-channel CATV system for distributing ITV to schools makes sense. The study showed that cable could be cheaper than ITFS in locations with population densities as low as 400 people per square mile. Other factors, especially school enrollment density, would also influence the economic viability of cable. It is significant that the study showed 37 entire metropolitan areas to be potentially suited for educational cable systems. [6]

In view of cable's economic advantages under specified conditions, it is certainly not inconceivable that the rather bold concept of a dedicated large capacity cable system will be tried in some localities. When developing the concept of an educational telecommunications system of national scope, however, it is necessary to bear in mind that dedicated cable systems would be viable for only a few of the 20,768 "places" identified in the 1970 Census. It is also important to consider the likelihood that commercial CATV operators will offer many programs that would be of interest to school -- news events, distant ETV stations, documentaries, proprietary educational programs such as those proposed by Hughes, etc. This means that schools would have to connect with two separate cable systems, which is perhaps a minor point. What is probably not so minor a point is the opposition from a powerful CATV lobby that could be expected. Major market cable systems will be required to have at least 20 channels. Some will have more. While these systems may not be able to meet all of education's channel requirements, they will probably be expecting to have the school market fill some of their channels. If it were to be proposed that a dedicated system totally preempt the education market, serious political difficulties would not be surprising.

Singh [96] and others have discussed the possibility of the educational community owning non-dedicated cable systems on either a profit or non-profit basis. This would avoid the necessity of dual cable systems and still allow educators to reserve the amount of channel space needed. However, almost 3000 CATV systems are already in place, all but a handful of them being under commercial ownership. Therefore, educational telecommunications system planners should treat educator-owned cable in the same way as they should treat dedicated cable-- as a distinct possibility in occasional situations where the conditions are right, but not as something to be counted on.

5.3 Two Latent Technologies for Local/Regional Distribution -- MDS and SCA

5.3.1 Multipoint Distribution Service

A relatively unheralded opportunity for local and district-wide distribution of educational services from a single headend is the Multipoint Distribution Service (MDS) which has been allocated the 2150-2160 MHz band. [97] The Federal Communications Commission has proposed increasing the bandwidth to 12 MHz (2150-2162). This would provide two omnidirectional television equivalent bands for each MDS system. While the potential is very limited (two TV channels would be only half of what ITFS systems provide), it should not be overlooked as a possible supplemental service. So far there have been applications for MDS grants in at least 144 cities. Most recently, attention has been focused on MDS as an alternative means of delivering pay TV. But the applicants have been organizations intending to operate the MDS service on a common carrier basis, so that the possibility exists for occasional use by educators. Headends for MDS systems are estimated to cost in the $50,000 range. The special receiving units required to unscramble MDS transmissions would cost about $1500. The F.C.C. has proposed that the MDS operator be required to control the receiving units. A one-hour television transmission would cost an estimated $75. At that price, per school costs for distribution of a program to ten schools would be $7.50, a reasonable expense. Schools equipped with recording and playback equipment could tape programs and use them when desired.

5.3.2 Subsidiary Communications Authorization (SCA)

A similarly uncultivated medium which probably has even broader application for educational needs than does MDS is the use of FM channel subcarrier frequencies, permitted by the Subsidiary Communications Authorization (SCA). SCA has been used to distribute commercial music services but has other applications too. Reception requires a special receiver, as does MDS; so SCA is especially suitable for directing services to specialized audiences. Although a SCA channel is not adequate for video transmission (the bandwidth is only 16 KHz), it has been used for such services as instructional radio and facsimile. The Oklahoma welfare department, for example, plans to use SCA to distribute programming to 12,000 blind and otherwise handicapped persons. A statewide network is expected within two years. [98]

5.4 Transmission-Localized Service Tradeoffs

In a previous section on "access," there was a discussion of the impact of various methods of scheduling on user control. Independent demand access and operator scheduling were identified as representing the extremes of total user control and no user control, respectively. The ability of a user to record and store an operator scheduled transmission for later playback and repetitive scheduling were mentioned as compromises which retained control with the operator but which emancipated the user from total dependency on the operator's timing decisions. Additional mitigation of total operator control was said to be possible to the extent that the user was able to reach the operator and influence his decisions.

Implicit in these various methods are a number of tradeoffs with cost and distribution system capacity factors. The tradeoffs are difficult to analyze in quantitative terms, because there is no precise measure of how much a change in the input of a given factor affects the system's utility for users. Nevertheless, it is useful to at least mention what the factors are.

The Denzau and Barnett analysis of the potential for dedicated cable systems [5,6] highlights one crucial item. When distribution system capacity is abundant, as it would be in a 40-channel CATV system, the way that capacity will be utilized and depended upon is quite different from a situation where capacity is in short supply. The study envisions an evolutionary development of an educational system, beginning with total teacher control over non-interconnected video recorders, TV sets, cameras etc. In the second stage of the evolutionary process, enlarged use of ITV is accomplished by some expansion of the decentralized system of recorders and programs and by wired schools in which programs are distributed from school headends on teacher request. In the third stage, a city headend serving a large number of schools is introduced into the distribution mix. At this point an analysis is made of the tradeoffs between the use of 4-channel ITFS or four channels leased from the local CATV system and the development of a dedicated 40-channel cable system. If one of the four-channel systems is adopted, channel capacity is not sufficient to serve the diverse program and scheduling needs of schools in the network. Therefore some school headend activity is retained, albeit at a reduced level of equipment, personnel, software, etc. The reduced level of school headend capability and consequent decrease in scheduling flexibility is compensated for by limited repetition of programs over the four-channel system. Investing in demand access capability would also be an offset to reduced school headend activity.

In the case of a 40-channel dedicated system, however, a total trade of distribution system capacity for school headend activity is made. The ten-fold increase in channel capacity permits maintenance of school scheduling flexibility through frequent repetitions of programs. The increased investment in system centralization is justified only by an accompanying increase in the number of students served and the number of hours of programming distributed. If only a few schools are involved, it is naturally less expensive to increase each school's capability separately than to invest in a costly city distribution system.

A general analysis of the cost comparison between four-channel ITFS and four-channel CATV was also made. The conclusion, logically enough, was that cable becomes more effective cost-wise where many schools are closely clustered. But as population becomes more sparsely distributed and cable mileage increases, ITFS (for which cost is distance independent) becomes more cost attractive. This observation also holds true for satellite distribution. That is, in very dense urban areas, it may prove more economical to distribute to a single headend, with further distribution by cable, than to place an earth terminal at every consumption point.

As depicted in Figure 11, the basic tradeoff is between service-enhancing methods involving greater investment in distribution system capacity (i.e., independent demand access and repetitive scheduling) and those involving heavier investment in local activity (i.e., local recording and storage and local production). One difficulty in arriving at meaningful comparisons lies in assessing the value a user would place on frequently repeated programming or demand access compared to the value placed on localized control. How many program repetitions, for example, compensate for loss of local production or storage capability?

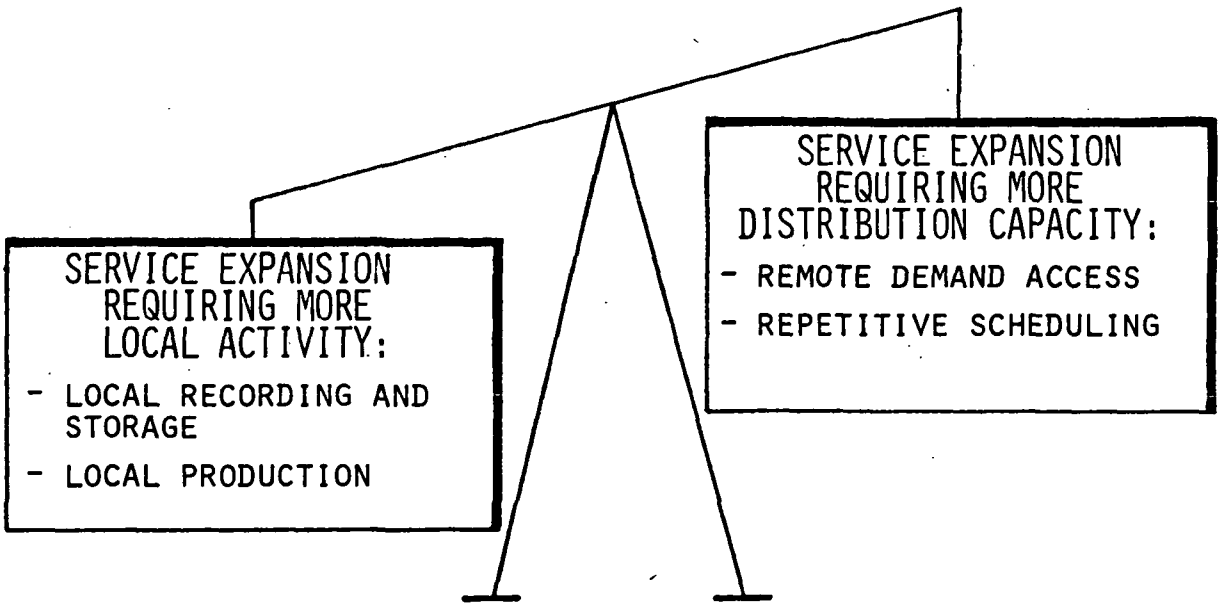

FIGURE 11

TRANSMISSION SYSTEM CAPACITY/LOCAL ACTIVITY TRADEOFF

Assuming that meaningful analysis can be made, one needs to recognize that in the real world it is often necessary to settle for less than what is optimal cost-wise. The theoretically ideal mix may call for large satellite transmission system capacity with delivery to cable headends, especially in dense urban areas. But as a wide array non-educational broadband services develops the educational community may not be able to obtain the necessary cable channel capacity. Since the educational community has only limited control over the development of these local distribution systems, it must accept them pretty much as they are and accordingly manipulate the systems over which more control is held. It may be necessary, if less efficient, to invest in low-cost earth terminals for every user or to increase local headend recording capability. Since the channel requirements for many two-way services, such as CAI dialog or requesting links, are assymetrical -- i.e., incoming signals would require greater bandwidth than return signals -- a few split CATV channels could be used for return feeds, while incoming signals would be delivered directly to consumption points.

5.5 Reaching Rural Areas -- Statement of the Problem

While urban areas face the complicated problem of choosing among alternative distribution systems, rural areas face the problem of not having any systems from which to choose.

The virtue of engaging in an intensive effort to deliver educational telecommunications services to rural areas is open to question. Goldmark [99] and other proponents of rural development have suggested that using electronic communications to deliver services to rural areas can make rural life more appealing and thereby reverse the migration toward urban areas, where congestion strains the supply of natural resources and human civility. Others, such as Peter Morrison [100] have said that movements from rural to urban areas should be organized, not curtailed. According to this view, People move to urban areas in pursuit of opportunity, and public policy should be designed to facilitate this pursuit through the provision of information about where opportunities are most prevalent, personal and family counseling to soften the cultural shock of sudden change in habitat, pre-employment interviews, transportation assistance, etc.

These opinions raise questions about the desirability of retarding migration from rural areas and about the kinds of communications services that ought to be delivered. Communications services designed to improve rural life would, in many instances, be quite different from those designed to make migration orderly and rational. While this debate goes on, though, 1970 Census figures indicate 26.5 percent of the population (53.9 million) residing in areas classified as rural. Of this number, 10.5 million persons were reported as residing in places with populations between 1,000 and 2,500. 43.4 million rural residents reside in places of fewer than 1,000 inhabitants. In order for these data to be fully revealing, information about the spatial distancing between rural populations would be required. If several population clusters of 1,000 are within short commuting distance of each other, the prospects for consolidating services (e.g., district learning centers) are better than if each small town is completely isolated.

Even without that information, there is sufficient information to indicate that reaching rural audiences with electronic delivery systems presents special problems. While satellites make possible point-to-rural area distribution never before possible, it is the relatively short-distance transfer of those services from satellite delivery point to consumption point that raises problems.

According to information from public broadcasting sources, 72 percent of the total U.S. population is within the coverage area of public television stations. [101] Roughly one fourth of the population is without access to public television services. That is approximately the same proportion of the population that is classified as rural. Although it cannot be said that rural populations and groups without access to public television match up one-for-one, it is safe to say there is significant overlap.

The Corporation for Public Broadcasting (CPB) and the National Association of Educational Broadcasters (NAEB) estimate it will require 330 public television stations to reach 95 percent of the population. [89] As of November 1971, 212 stations served 72 percent of the population. [101]* It is interesting to note that the then existing service to approximately 150 million people required one station for about every 707,000 persons (150 million ÷ 212). To reach most of the remaining 50 million people requires the addition of a station for about every 424,000 people (50 million ÷ 118). In terms of dollars, the CPB Task Force on Long Range Financing estimates $230 million to be currently invested in public broadcasting. According to their estimate, it would take an additional $334 million to broaden coverage from the current level to 90 percent of the potential audience by building additional broadcasting stations. [102]**

The message is reasonably clear. As the percentage of the population served by telecommunications systems approaches the saturation point, it is going to become more difficult (and more expensive) to reach the remaining population. Having resigned itself to that, and barring a new technology which can change the picture, the country still needs to search for the most economical way to deliver telecommunications-based educational services to rural areas.

The educational broadcasting community is very much in favor of using satellites to create a more flexible public broadcasting network and to penetrate markets currently without educational television service. However, educational broadcasters have not always been so receptive to alternative and potentially more economical delivery systems. In 1963, NAEB strongly opposed a request by the

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* Since 1972, the number of stations has increased. According to Figures compiled by the FCC April 30, 1973 and published by Broadcasting (June 4), 224 educational stations were on the air. An additional 11 were authorized but not yet on the air.

** These estimates do not take account of the potential for extending coverage by other technologies, such as cable, translator stations and satellites.

airborne television project (MPATI) for an allocation of additional UHF channels so that it could offer greater scheduling flexibility. [30] NAEB contended that allocation of the requested channels to MPATI would preempt channels needed to expand the ground-based educational broadcasting system. NAEB also argued that a regional instructional television system such as MPATI would be contrary to local control of the educational process and would discourage establishment of local television outlets. NAEB's opposition and other considerations resulted in F.C.C. denial of the MPATI request, which led to dissolution of the airborne system.

For at least three reasons, educational broadcasters now take a more favorable attitude toward technologies such as satellites and cable as means of extending educational television coverage. First, these technologies do not compete for educational UHF channels. Second, a decade of growth in the number of local outlets has transpired since the MPATI proposal; so, there is no longer as strong an element of threat to future establishment of local stations. Third, there is recognition that regional or national systems are the only viable alternative for many isolated and sparsely populated areas which are incapable of supporting local outlets. In addition, there has been a good deal of discussion about a second PBS service for distribution of instructional programming. Since only a few cities have been allocated more than one educational channel, attention has focussed on satellite interconnection of cable headends as the means of distribution.

The paucity of communications channels in rural areas is not limited to public television. Different states have shortages of different media. But a review of the distribution of various communications services in the United States shows certain areas of the country to be short on all of the services. By and large, the picture is most serious in the Rocky Mountain States, Alaska, Appalachia and the Plains States (except Nebraska).* A check of sparsely populated states in TABLE 3 against the figures showing distribution of educational radio, ETV, intra- and interstate television networks, ITFS, and projected CATV (FIGURES 12-16) shows a strong correlation between population sparseness and lack of communications service.

To improve the local and regional communications situation in rural areas, more attention might be given to such possibilities as Responsive Television (RTV), which makes possible interactive learning without the need for return links. The incoming signal may be originated from a remote point, but the viewer response is processed locally. [103] Another possibility would be roving transmitter vans, which could circulate in rural areas to provide return link capability.

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* Nebraska, a state of 1 1/2 million residents, stands in sharp contrast to the other Plains States where ETV is concerned. With 9 public television stations, 8 of them under control of the state ETV commission, Nebraska is well served. The Great Plains National Instructional Television Library (GPNITL) is located at the University of Nebraska.

TABLE 3

STATES IN ORDER OF POPULATION DENSITY

People per sq. mile	State	People per sq. mile	State
0.5	Alaska	79.0	Georgia
3.4	Wyoming	81.1	Louisiana
4.4	Nevada	81.1	Wisconsin
4.8	Montana	81.2	Kentucky
8.4	New Mexico	81.7	New Hampshire
8.6	Idaho	85.7	South Carolina
8.8	South Dakota	95.0	Tennesee
8.9	North Dakota	104.1	North Carolina
12.9	Utah	116.9	Virginia
15.6	Arizona	119.8	Hawaii
19.4	Nebraska	125.5	Florida
21.3	Colorado	127.6	California
21.7	Oregon	143.9	Indiana
27.5	Kansas	156.2	Michigan
32.1	Maine	199.4	Illinois
37.0	Arkansas	260.0	Ohio
37.2	Oklahoma	262.3	Pennsylvania
42.7	Texas	276.5	Delaware
46.9	Mississippi	380.3	New York
48.0	Minnesota	396.6	Maryland
48.0	Vermont	623.7	Connecticut
50.5	Iowa	727.0	Massachusetts
51.2	Washington	905.4	Rhode Island
67.8	Missouri	953.1	New Jersey
67.9	Alabama	12,401.8	District of Columbia
72.5	West Virginia		

From: The 1972 Word Almanac and Book of Facts
Newspaper Enterprise Association, Inc. New York

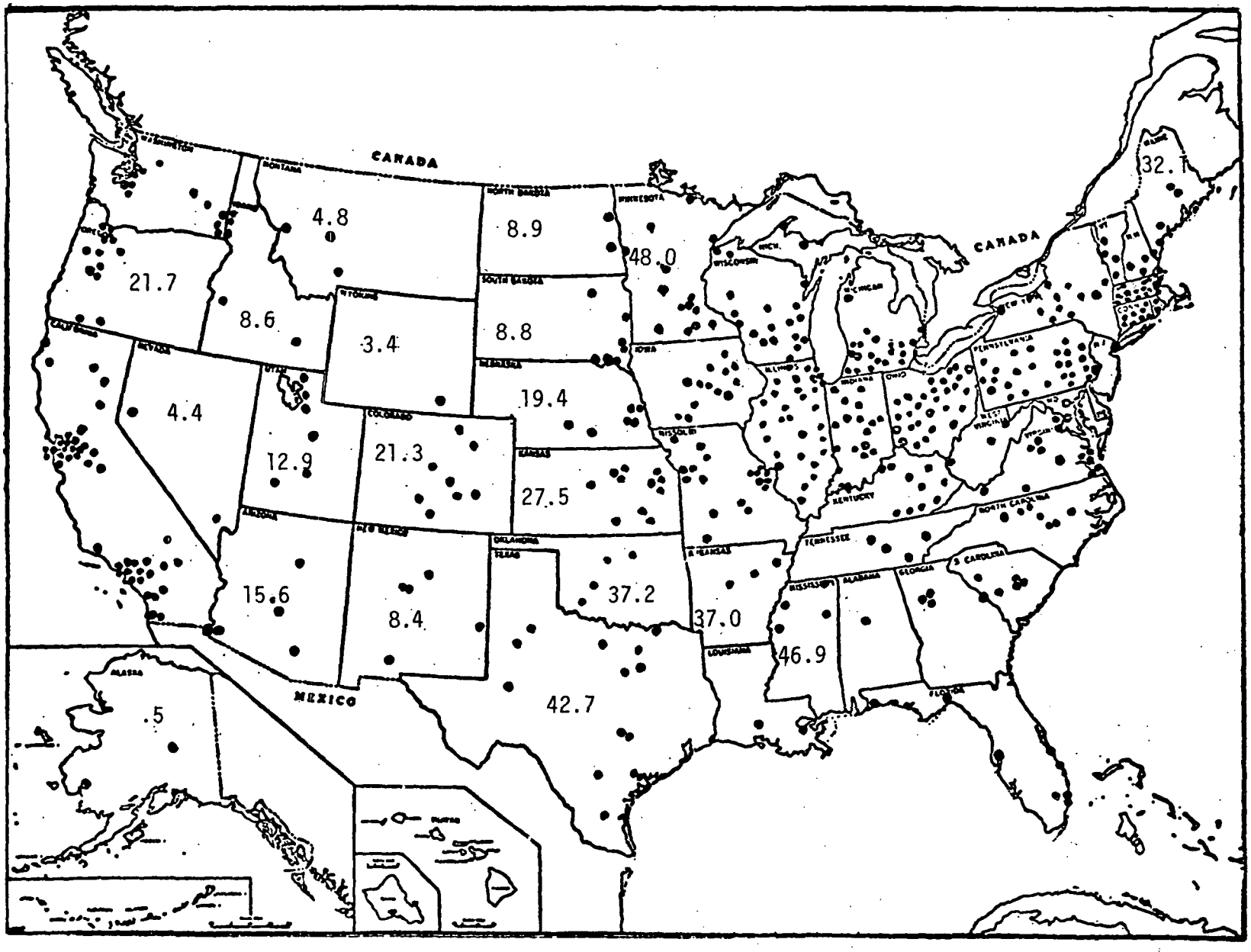
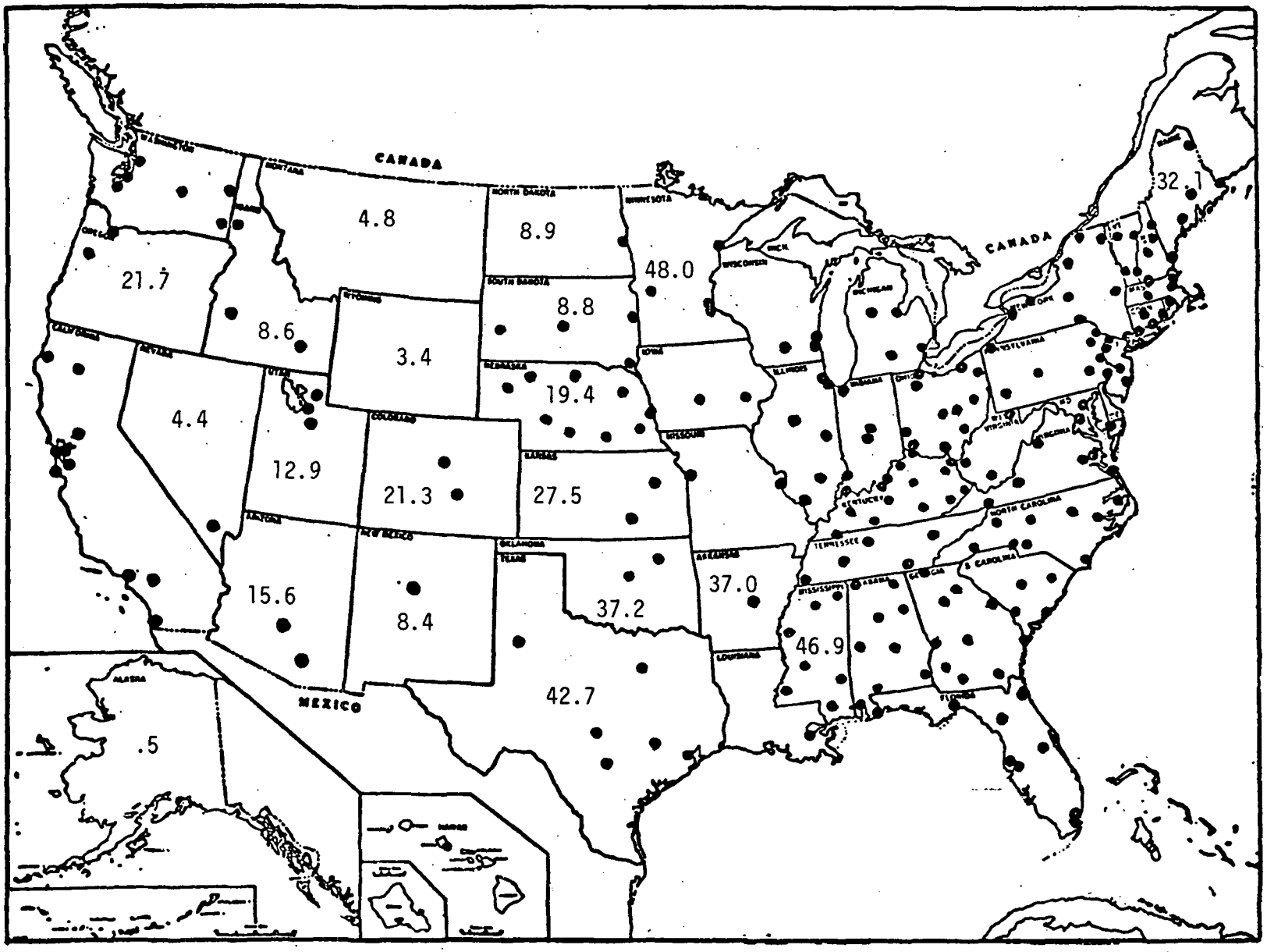


FIGURE 12
DISTRIBUTION OF EDUCATIONAL RADIO STATIONS AND POPULATION DENSITIES OF STATES [Ref. 103]

* States with densities indicated on the map are the 20 least densely populated.



* States with densities indicated on the map are the 20 least densely populated.

FIGURE 13
DISTRIBUTION OF EDUCATIONAL TELEVISION STATIONS AND DENSITIES OF STATES [Ref. 103]

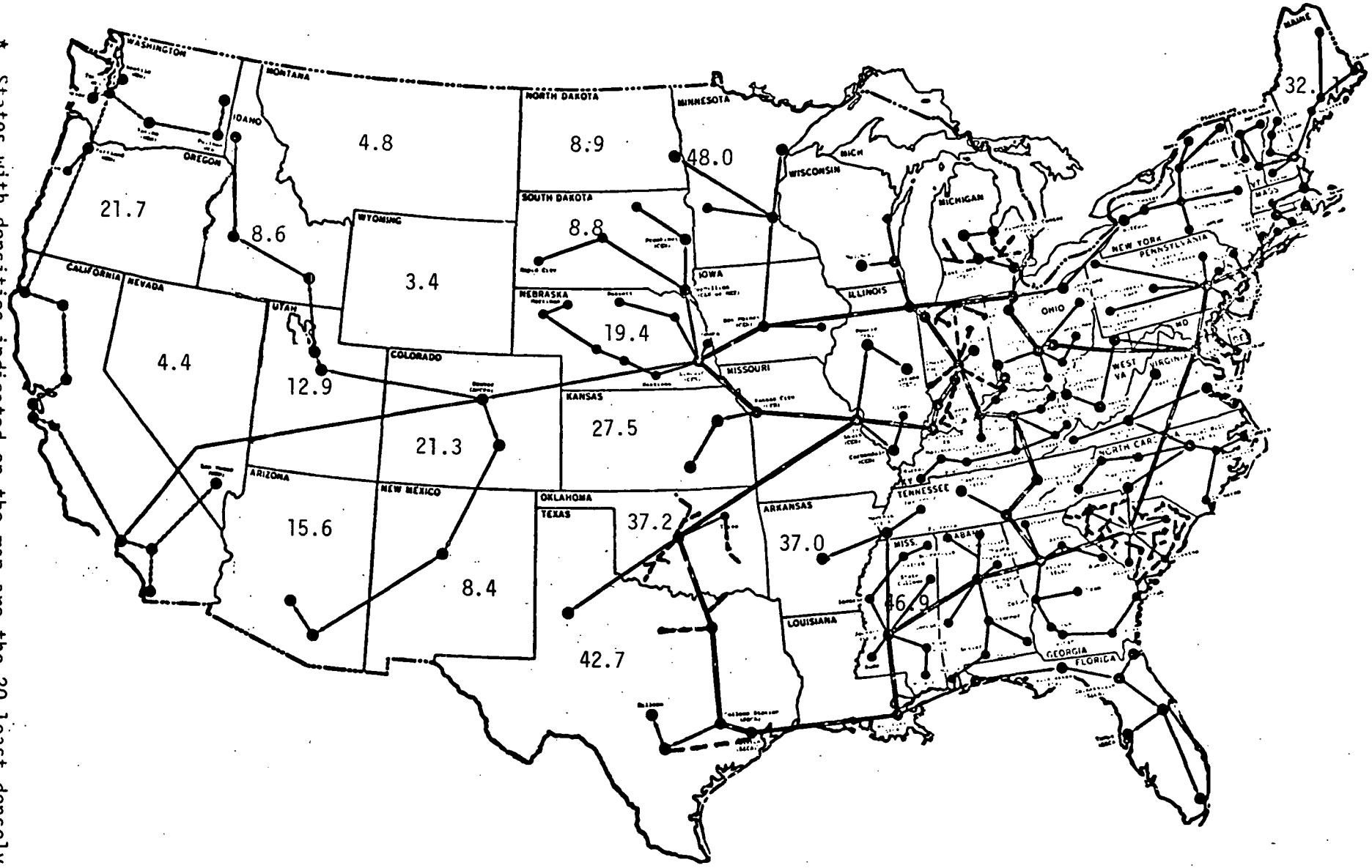


FIGURE 14
INTERSTATE AND INTRASTATE EDUCATIONAL COMMUNICATION NETWORKS AND POPULATION DENSITIES OF STATES [Ref. 4]

* States with densities indicated on the map are the 20 least densely populated.

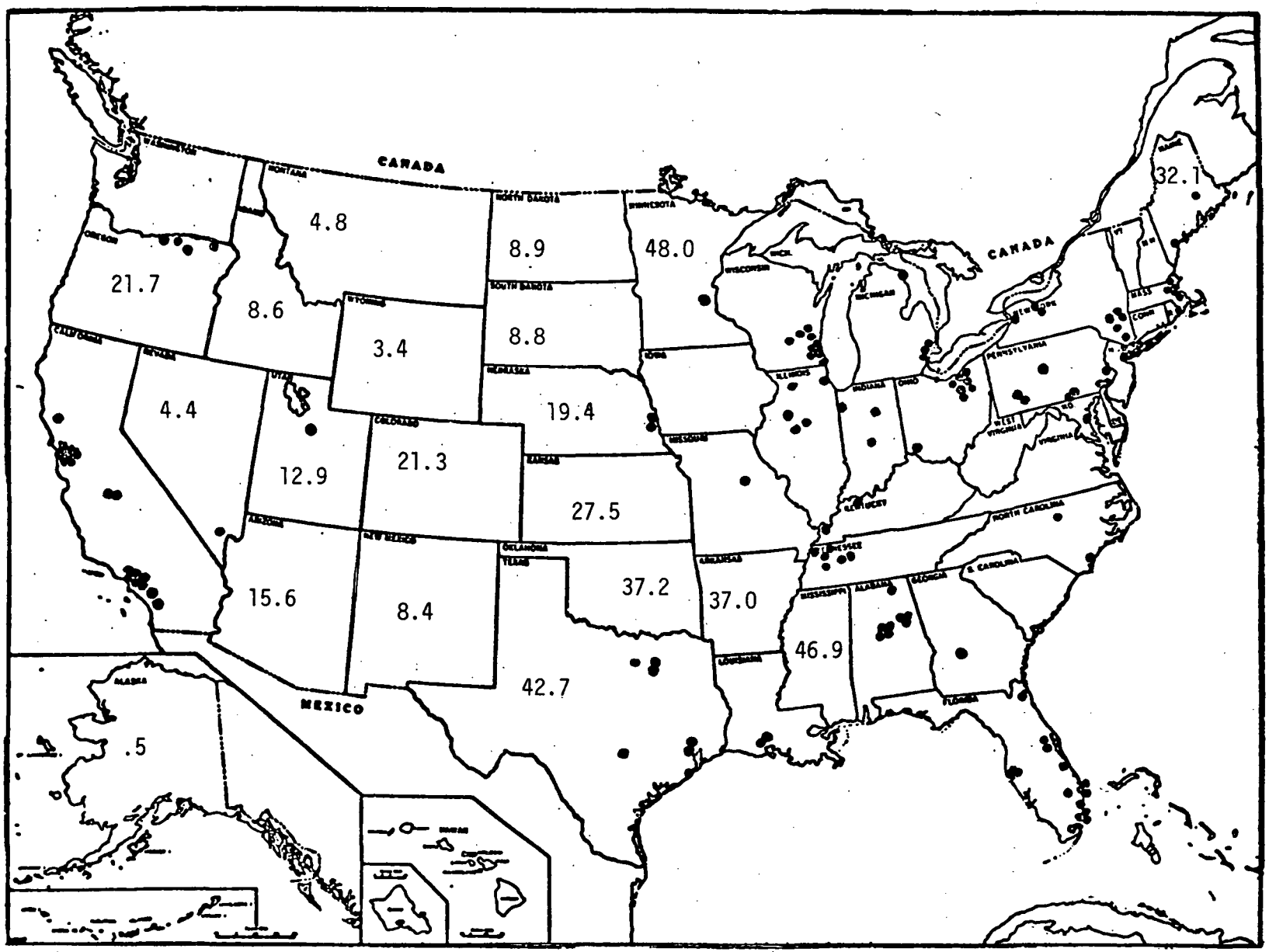
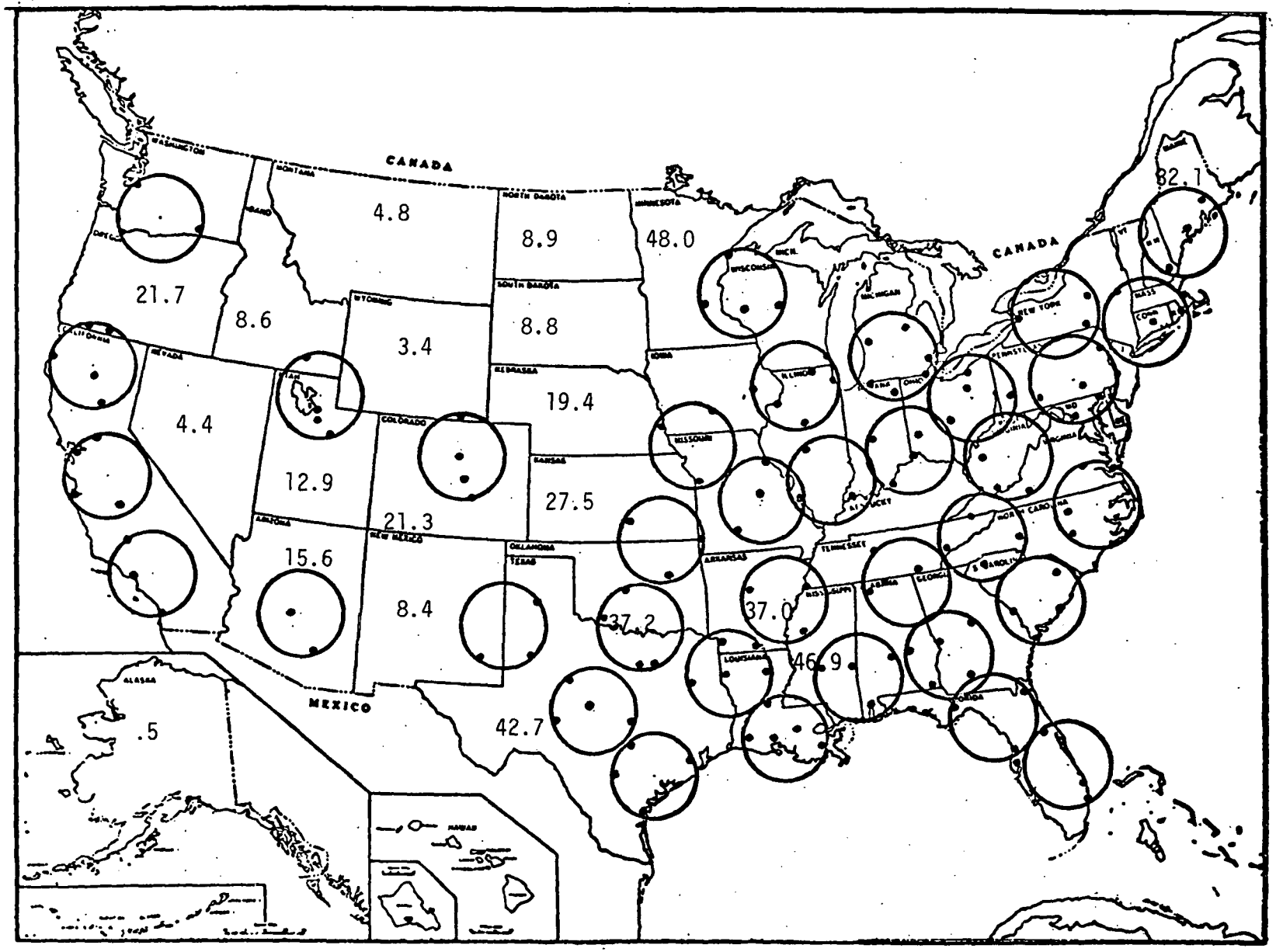


FIGURE 15
DISTRIBUTION OF ITFS INSTALLATIONS AND POPULATION DENSITIES OF STATES [Ref. 103]

* States with densities indicated on the map are the 20 least densely populated.



* States with densities indicated on the map are the 20 least densely populated.

FIGURE 16
PROJECTED CATV SERVICE AREAS IN 1975 AND POPULATION DENSITIES OF STATES [Ref. 103]

But even these possibilities probably could not change the fact that equalizing access in rural areas will require more investment per learner. Since price is an ingredient of "access", a need for some degree of subsidization to equalize buying power is indicated.

6. A Word About Consequences

A subsequent memorandum will describe some specific alternative organizational structures. This memorandum is intended as a prelude to that. In a sense, however, analyses of the issues which have been discussed in the preceding pages may be of more lasting importance. The interim between now and the date when a full scale telecommunications system for education is implemented is likely to see changes in the nation's perceptions of its needs and priorities. Five or ten years hence, resolution of the issues raised here may be accomplished on the basis of values and considerations different from those which would guide us today. At Washington University, a study using the Delphi methodology to appraise the future of technology in education, including the values and opinions which might affect utilization levels and organizational structure, is near completion. The issues to be decided on the basis of those future values will likely be much the same as those discussed here: questions relating to ownership, management, financing, programming, placement of origination and delivery points etc.

Earlier, reference was made to the potential danger of designing a system in which operators could initiate transmissions from users without their knowledge or consent. This and many other issues concerning the social consequences of information networks are in need of analysis. Even though it is impossible to make exact predictions of the secondary impacts of educational networking, every effort should be made to anticipate the possibilities and to incorporate safeguards against undesirable effects into system design. Issues needing analysis include:

1. Privacy invasion resulting from data banks and monitoring use of the information system.

2. Excessive program standardization dictated by the economics of large-scale delivery.

3. Information over-load caused by expanding the number of information channels and program choices.

4. Reduction of common human experience, resulting from increased diversity; impact on social and political cohesion.

5. Reduced social intercourse resulting from substitution of home-based learning for face-to-face activities.

6. Programmed learning and telecommunications-based delivery: implications for thought and behavior control.

7. Changing employment patterns resulting from machine displacement of teachers.

8. Potential for unintentional expansion of the gap between the information haves and have-nots.

9. Implications of equalized educational opportunity without (or with) accompanying equalization of social and economic opportunity.

These are questions of monumental proportion and require on-going assessment before, during and after system implementation. To the extent possible, the organizational design effort at Washington University will take these into account.

CONCLUSIONS

This memorandum has addressed several important questions which should be considered in designing possible organizational frameworks for development and control of a large scale educational telecommunications system using fixed/broadcast satellites as a major component. The following are some of the more important conclusions which may be drawn from this analysis:

1. In many respects, the challenge of organizational design is one of making the system accessible to both suppliers and users of services. Access is a multifaceted concept affected by the way in which the system is financed, by the administrative methods used to apportion channels among users, by restrictions placed on the use of software materials through copyright procedures, by the degree to which scheduling is determined by users, and by proximity of users to facilities and decision makers.

2. In choosing among numerous private and public ownership alternatives for any of the several system components, superficial assumptions about the "inherent" efficiency of private enterprise or the "inherent" social responsibility of public enterprise should be avoided. These qualities are not inherent to either sector. They need to be planned in by system designers, just as negative qualities need to be "planned out."

3. Where possible, system financing should be structured so that users control the purse and, hence, possess the power to define services. Where necessary to promote equitable distribution of services and to meet high priorities, subsidies should be used. But great care should be exercised in the design of subsidies. Indirect educational subsidies earmarked for telecommunications-based services could eventually lead to a two-track educational delivery system, in which less affluent learners would learn through electronic media while the more affluent would continue to learn in face-to-face settings when preferable to telecommunications-based education.

4. Integrated control of the various components which constitute a large scale educational telecommunications system will be desirable in some instances to decrease investor risks and to facilitate smooth operations, but careful efforts should be made to avoid potentially anti-competitive effects of integration. Integrated control of transmission system and programming has significantly harmful potential, especially if a government operator is involved.

5. Copyright clearance procedures need to be modernized to minimize red tape while still protecting creators' rights to compensation from those who use their works.

6. Although economies of scale require sharing of resources, acceptance of educational telecommunications services depends on maximizing the individual user's control over scheduling through such means as local recording and demand access.

7. A number of public initiatives are required to set in motion development of large scale telecommunications. These may include various financial incentives to private enterprise, experiments and demonstrations, and promotional/marketing assistance. Educational satellite demonstrations under simulated market conditions, as discussed in PART A, Section 6.4, would be especially useful.

8. Software development by diverse public and private sources can be anticipated and should be encouraged. A tripartite effort is envisioned, in which research and development takes place in the education sector and packaging and marketing in the private sector. The role of the third partner, government, is seen as one of sponsoring research and bringing education and business together for cooperative ventures.

9. Large software storage/origination centers, with direct uplink access to satellites is envisioned. For various political reasons, regional or state centers may be the most practical arrangement of such centers. However, the arrangement which would possibly take greatest advantage of satellites' ability to economically link widely separated users with common educational interests would be specialized centers serving nationwide constituencies.

10. The greatest potential for educational applications of satellites rests with a configuration of high power satellites and small, inexpensive ground terminals located at schools, community centers, cable headends, etc. On the one hand, lack of demonstrated market potential makes private development of such a system unlikely. On the other hand, public development seems unlikely because of fiscal constraints and growing concern about possible government control of communications channels. This impasse might be broken by various public efforts to stimulate private enterprise. Ventures analagous to rural electrification, publicly owned systems leased to private business, and governmental development followed by sale to private operators are all possibilities which should be considered.

11. It is important not to underestimate the need to develop local and regional ground distribution systems to deliver satellite signals to points-of-use, especially to home-based users. Although the U.S. has an elaborate infrastructure of broadcasting stations, cable systems, telephone lines and microwave, many of these systems are severely lacking in rural areas. Public initiatives in the form of subsidies are needed to develop ground distribution systems in these areas if they are to fully benefit from satellite technology.

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