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PN-AAD-938

August 1968

Volume I

SATELLITE-DISTRIBUTED EDUCATIONAL TELEVISION FOR DEVELOPING COUNTRIES — SUMMARY REPORT

Prepared for:

AGENCY FOR INTERNATIONAL DEVELOPMENT
WASHINGTON, D.C.

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SRI Project 7150

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PREFACE

In March 1968, the U.S. Agency for International Development, in support of the President's Task Force on Communications Policy, contracted with Stanford Research Institute to study educational applications of communication satellites for developing countries. The study was designed to determine the potential of satellite-delivered educational broadcasts through analyses of two developing regions. A single large nation, India, and a multinational region, Latin America, were chosen as case studies to illustrate the scope of possible applications. The emphasis of the case studies was to be on the educational, economic, cultural, organizational, and political factors affecting the feasibility and utility of satellite communications.

This report contains an overview of the case studies. Volumes in the project series include:

Volume I: Satellite-Distributed Educational Television for Developing Countries--Summary

Volume II: Communication Satellites for Education and Development--the Case of India

Volume III: Satellite-Distributed Educational Television for Developing Countries--the Case of Latin America

Volume IV: Satellite-Distributed Educational Television for Developing Countries--Working Papers

1. Nonhardware Components of an Instructional Television System for a Developing Country
2. Considerations in Deciding Whether and How to Introduce an Educational Satellite
3. Film Versus Television in Education
4. Technical Considerations of Satellite Communication Systems for Education
5. Political Obstacles to Adoption of Educational Television
6. Economic Analysis of the Alternative Distribution Systems for Educational Television
7. The Role of Radio in Supporting Educational Television

CONTENTS

PREFACE iii

INTRODUCTION 1

APPLICATIONS OF ETV 7

DEMAND ESTIMATES 9

SYSTEMS COMPARISONS 15

A NOTE TO PROSPECTIVE USER COUNTRIES 37

POLICY IMPLICATIONS FOR THE UNITED STATES 41

ILLUSTRATIONS

1 Study Design, Satellite-Distributed ETV in Latin America . . . 5

2 Study Design, Communication Satellites for Education and Development in India 6

3 Alternative ETV Distribution Modes 16

TABLES

1 Latin American Demand for ETV Applications in Viewer Hours per Week: 1968, 1972, 1980 13

2 Relative Performance of Alternative Distribution Systems . . . 17

3 Five TV Distribution Systems for India: Total Capital and Operating Costs Over 20 Years and Average Cost per Year . . . 26

4 Comparisons of Annual Costs of a Combination Satellite and Ground-Based System With Economic Indicators for India, at Five-Year Intervals 28

5 Latin American ETV Distribution Systems Costs, 1980 29

6 Costs of Two ETV Distribution Systems to Meet 1980 Demand: Latin American Totals and Percent Distribution by Cost Element 34

INTRODUCTION

Satellite communication would appear to offer potential for accelerating the modernization process in developing countries. Distant cities and villages in a single country or a multinational region can be linked by satellite as easily as adjacent cities. The source of programming can be any properly equipped transmitting ground station. The same message or lesson can be received simultaneously by all stations that are equipped to receive the satellite signal. A satellite communication network need not wait for the construction of expensive terrestrial microwave links.

The satellite technology used to distribute ETV (educational television) may therefore provide the key for solving several stubborn problems of human resources development. Not only can it overcome terrain and distance, it may also be able to reform and modernize educational systems more rapidly than would otherwise be possible, give more people access to education and training, place the best teachers within reach of large audiences, help to integrate large sectors of the population into the social, economic and cultural life of the nation or region, and contribute to international understanding. Skillfully programmed, satellite-distributed ETV may be able to overleap the literacy barrier by bringing illiterates into some participation in the modern sector. If the technology realizes only some of these promises, it can help to accelerate economic and social development.

To explore some of the potentials of satellite communication, the U.S. Agency for International Development and the President's Task Force on Communications Policy commissioned SRI to make case studies of two developing regions. The regions India and Latin America were selected to reflect a variety of conditions, with the hope that some generalizations for other developing areas could be based on findings of the research.

India represents the case of a single nation with a population of 500 million, but sufficiently compact that it has only one time zone, while Latin America represents a multinational region in both northern and southern hemispheres and has six time zones. India is a nation of villages: 80 percent of its population reside in 568,000 villages. A larger fraction of Latin America's population is concentrated in large urban areas separated by sparsely populated rural, mountain, desert, and jungle areas.

Several types of diversity affecting the design of communication systems are present in the two case regions. In India, 15 official languages are spoken--13 of them by more than 10 million people each. These languages are built deeply into the local cultures; people in a linguistic group have been known to burn trains that come into their areas with words in another linguistic alphabet painted on the coaches. Latin America, on the other hand, has but two main languages, although many Indian languages are spoken in the interior and in the mountains. Latin America's political diversity offers a complex challenge to a communications system that can span part or all of its 23 independent nations. In both regions there is considerable agricultural diversity.

There is also a range within each region and between the two regions with respect to the generally accepted indicators of modernization--industrialization, urbanization, literacy, per capita income, fractions of age cohorts enrolled in each level of schooling, and use of mass communication media. With respect to the last indicator, only 6,000 television receivers are in use in all of India, whereas over six million receivers were in use in Latin America in 1964.

In view of the characteristics of the two case settings and the respective interests of leaders to whom the study team members spoke, potentials for satellite communications technology in the two regions were examined from slighly different viewpoints. In India, an attempt was made to answer the following question: how might satellite communication technology be used to help India achieve overall development objectives, a central one of which is national integration for the many language and cultural groups? This problem was the preoccupation of the Indian leaders and planners interviewed during the field work. In Latin America, the question examined was of somewhat narrower scope, reflecting the more advanced state of broadcasting there and the concerns of Latin American officials: what can satellite communication technology contribute to the human resources development (education and training) objectives of individual countries and of the emerging Latin American community? In Latin America, there already exists for most urban areas a commercial television system and some applications of ETV.

Thus, the question examined in India was the fundamental one of proposing an entirely new national television system in the light of the availability of satellite technology. In Latin America, the question was

more sharply focused on the prospects for ETV relevant to the capabilities of satellite technology.

Satellite communication technology must be studied in context. Successively wider angles of vision would show that satellite communication technology is imbedded in educational broadcasting; educational broadcasting in the overall education and training system; and the education and training system in a country or region's economic and social development program. This context dictated the designs for the case studies. The logic of this design for the Latin American study is presented in Figure 1. Human resources development objectives were considered in the light of national and regional development objectives. Opportunities for broadcast media to help in achieving these human resources objectives were identified, and estimates were made of the present and projected demand for such applications of media. Preliminary system designs appropriate to the demand estimates were prepared, using alternatives of satellite and terrestrial delivery links. Cost, feasibility, and organizational implications of the alternatives thus generated were examined. The Indian study, designed for a country with very little television, had to begin at an earlier stage of mass communication development, as Figure 2 illustrates.

FIGURE 1

STUDY DESIGN

SATELLITE-DISTRIBUTED ETV IN LATIN AMERICA

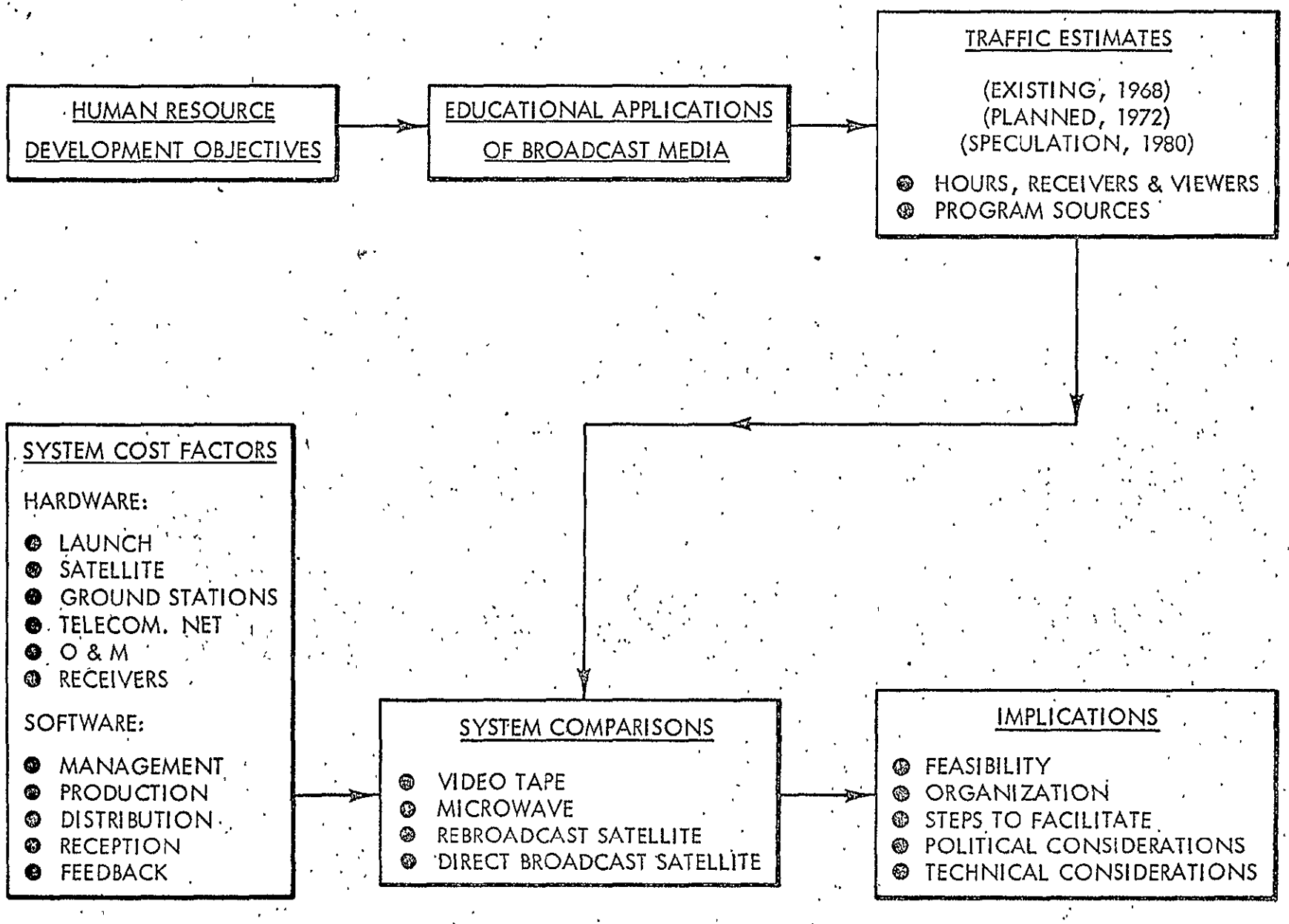
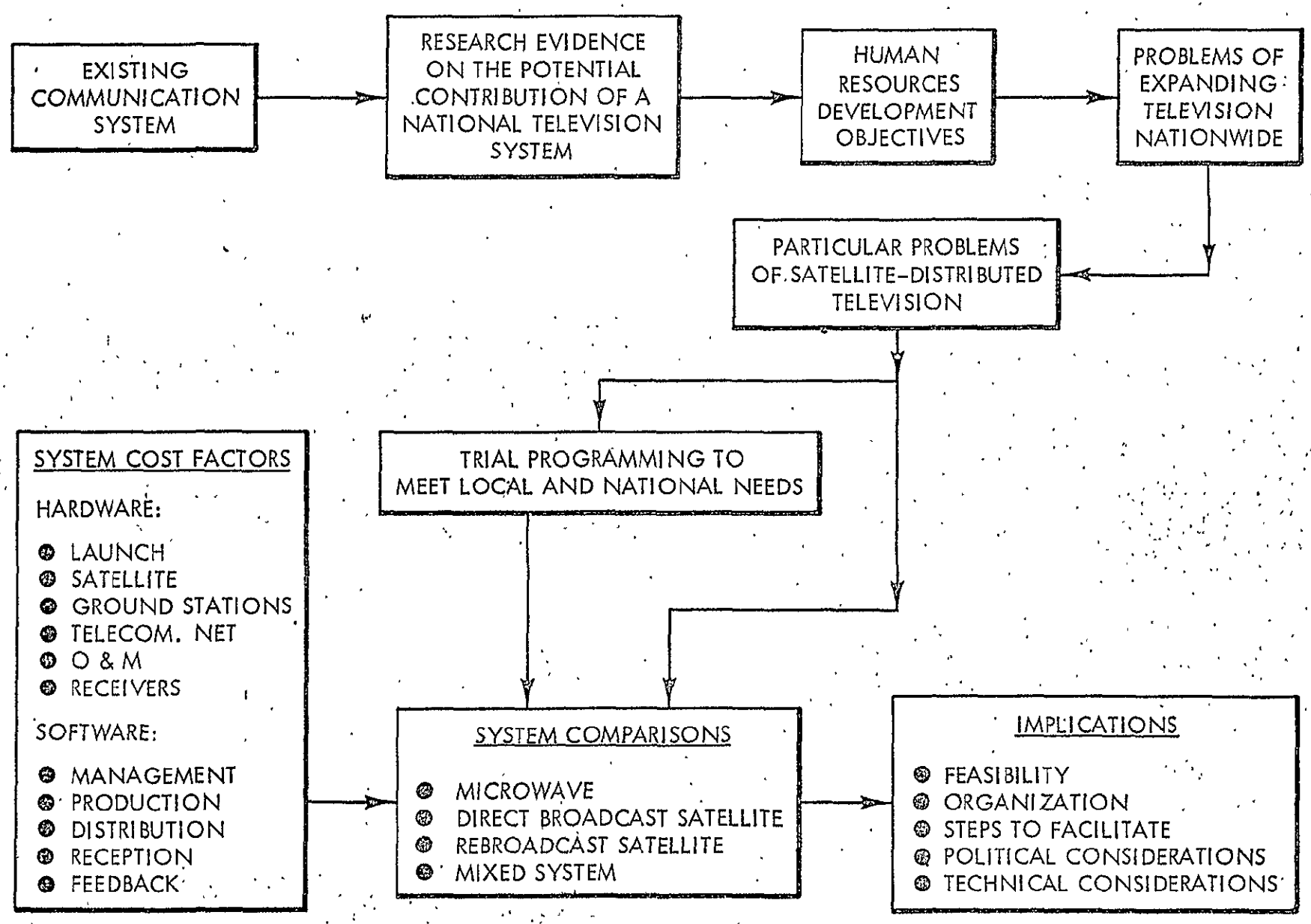


FIGURE 2

STUDY DESIGN

COMMUNICATION SATELLITES FOR EDUCATION AND DEVELOPMENT IN INDIA



APPLICATIONS OF ETV

In several Latin American countries, ETV is already contributing to the achievement of certain priority objectives for human resources development; for example, improvement of primary education in Colombia and Venezuela, accelerated secondary education in Brazil, and the provision of secondary education to students in Mexico who would otherwise lack access to such schooling. These applications appear to be most effective when ETV has been planned and managed as a system for pacing students and teachers as well and when special attention has been given to reception, thereby bringing the classroom teacher into full partnership with the studio teacher and program producer. This observation is supported by the growing body of research findings on the effectiveness of ETV.

ETV holds a significant, and sometimes a unique, potential for accelerating the achievement of the following development objectives stated by many Indian and Latin American leaders:

- Upgrade primary and secondary education by sharing the best teaching and the best demonstrations, thus more nearly equalizing the learning opportunities for all students.
- Modernize curriculum content throughout an entire educational system without having to wait for the training and retraining of the teaching staff.
- Reform teaching processes to encourage inquiry-oriented, problem-solving learning instead of tradional rote-memory instruction.

- Offer educational opportunities for the many who were unable to complete primary, secondary, or higher education cycles, but who now want to participate more fully in the labor force and in society.
- Strengthen the vocational and technical components of education to increase the relevance of training to employment opportunities.
- Offer new mathematics and new science instruction in secondary schools and in the basic cycles of higher education.

Indian officials added the following objectives that television could help to attain:

- Provide a common element in experience to further the goal of national integration.
- Bring about awareness of and interest in the family planning problem more swiftly and widely than otherwise possible.
- Assist in modernizing agriculture, and in general help to make rural life pleasant and rewarding enough to keep more of the ambitious and better-educated young people in the villages, where they are so badly needed.

DEMAND ESTIMATES

For both regions, the study teams interviewed local planners and media experts to estimate the amount and types of ETV programming that would be responsive to the foregoing objectives. These estimates were projected from the present to 1980 in Latin America and to 1988 in India. In the Indian case, special attention was given to preparing an illustrative program schedule that would go as far as possible in serving the needs of each of the major language and cultural groups found in India. This schedule shows that it would be possible, using a satellite with one video and two audio channels, to furnish weekly, for each of four languages: ten hours of school programs; nine hours of teacher training, vocational training, and literacy classes; nearly four hours of news and public events; three hours of agriculture, health, and family planning programs; two hours of children's programs; and nearly six hours of general cultural and entertainment programs. Using a satellite with three video channels and receivers equipped with two audio channels for each video channel, the foregoing amount of programming could be available for each of the 12 largest language groups in India.

In Latin America, ETV programming must also be localized, but for different reasons from those in India. First, there are the differences in school calendars, with nations in the south using the southern hemisphere schedule of February to November and those to the north using the school year of September to June. Next, there is the problem of six time

zones. And finally, there are the political considerations implicit among 17 sovereign Spanish-speaking nations, where one nation's course in history or geography may be heard in a neighboring country as propaganda.

Throughout the field work in Latin America, key personnel in education and training in each country were asked to assess the prospects for exchanging or sharing instructional programs among several countries. Most of the responses were pessimistic. Several obstacles were cited: variation in stages of economic development within Latin America; differences in political ideology and stability; differences in regional dialects and word meanings; differing interpretations of history; and the absence or weakness of educational, cultural, and economic ties between countries. (Many Latin American countries have more fully developed relationships with countries outside the continent than with their neighbors.)

A precondition for accepting common instructional programs would be efforts to harmonize curriculum content. Although committees of the Organization of American States have been formed to examine common curricular problems, only some cooperative efforts among Central American countries and beginning discussions of primary textbook cooperation among Venezuela, Colombia, and Ecuador have produced results so far. The most optimistic estimate of this study is that 25 percent of school broadcast time on Latin American satellites might be shared by 1980, given present educational diversity and political barriers.

The hours of programming per week required for the various applications of ETV can be summed to determine the number of ETV channels

required. In the Indian case, three ETV channels were projected as a realistic estimate of what India can afford and use fully in the near future. These three channels can easily be accommodated on a single satellite. In the Latin American countries where ETV is expected to grow most rapidly--Colombia and Brazil--four ETV channels each were projected for 1980. Either three or two channels were projected for each of the other countries studied. For the combined needs of 15* Latin American countries, a total of 14 ETV channels are likely to be needed by 1972, and 30 ETV channels by 1980. The larger number of channels for Latin America reflects the many national requirements, the assumption that about one-quarter of programmed hours will be shared internationally, and the advanced state of television development there. Three satellites could handle the 30 channels projected for 1980: one serving Mexico, Central America, Colombia and Venezuela; one serving Brazil; and a third serving Argentina, Bolivia, Chile, Peru and Uruguay.

The other dimension of ETV demand (in addition to hours per week of programming) is number of viewers or students served. For the Latin American case, this was estimated for participants in instructional programming, that is, for situations in which reception is organized and a classroom teacher or monitor is present. Estimates were prepared for 1968, 1972, and 1980 for each of 12 educational applications.

The product of the number of viewers multiplied by the hours per week that those viewers are engaged in watching instructional programs

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* The time available for the project permitted including only 15 of the 23 Latin American countries.

is a useful measure of demand. It is a better measure than the number of viewers unweighted by programming frequency and intensity, because some educational programs may appear only one-half hour per week, while other applications may be shown daily in both the morning and afternoon. Table 1 has been prepared from the Latin American demand estimates for 1968, 1972, and 1980 to reflect this measure of viewer hours per week. If the number of viewer hours per week is expressed as an index of 100 for 1968, the index for 1972 would be 212, and for 1980, 1,410. In other words, in 12 years a 14-fold increase could be expected. The number of students reached by organized reception would increase from the present figure of 630,000 to over 10 million in 1980.

In the Indian case study, the planning for an entire television communication system put emphasis on estimating overall demand of viewers reached by public information programming and other applications supporting the objective of national integration. Therefore, estimates of viewer hours in organized reception were felt to be too speculative and were not prepared. A phased development program was prepared, however, with the goal of making television available to 80 to 85 percent of the Indian people within 20 years.

Table 1

LATIN AMERICAN DEMAND FOR ETV APPLICATIONS IN VIEWER HOURS PER WEEK: 1968, 1972, 1980
(Viewer Hours per Week in Thousands)

ETV Application	Central America			Mexico			Colombia		
	1968	1972	1980	1968	1972	1980	1968	1972	1980
Adult education	--	--	100.0	375.0	750.0	750.0	--	70.0	500.0
Teacher training, preservice	--	6.0	152.0	--	--	50.0	--	50.0	176.0
Teacher training, inservice	--	20.0	4.4	0.8	6.6	3.0	3.6	10.0	23.2
Primary education, kindergarten	--	--	165.0	--	--	600.0	--	--	175.0
Primary education	--	9.1	10,395.0	30.0	150.0	--	585.0	6,750.0	57,200.0
Secondary education	--	2,000.0	6,000.0	130.0	2,500.0	7,500.0	--	300.0	5,400.0
Technical training	--	--	20.0	--	--	60.0	--	--	50.0
Higher education, science & math	--	--	60.0	90.0	180.0	600.0	0.5	60.0	150.0
Higher education, lecture series	--	--	--	--	--	70.0	--	--	17.5
Higher education, TV college	--	--	--	--	--	45.0	--	--	--
Higher education, continuing professional	--	--	4.0	--	--	35.0	--	--	15.0
Total		2,035.1	16,900.4	625.8	3,586.6	9,713.0	5,854.1	7,240.0	63,706.7

ETV Application	Venezuela			Brazil			Argentina		
	1968	1972	1980	1968	1972	1980	1968	1972	1980
Adult education	--	--	--	200.0	480.0	1,500.0	--	--	--
Teacher training, preservice	--	--	92.0	--	--	208.0	--	--	44.0
Teacher training, inservice	0.2	0.5	11.0	--	--	34.2	--	--	2.2
Primary education, kindergarten	27.0	120.0	175.0	--	--	385.0	--	--	125.0
Primary education	225.0	1,125.0	15,625.0	60.0	180.0	30,000.0	--	--	4,625.0
Secondary education	30.0	30.0	2,250.0	22.5	60.0	3,510.0	--	--	1,200.0
Technical training	--	--	40.0	39.0	110.0	216.0	--	7.5	60.0
Higher education, science & math	--	90.0	150.0	--	--	120.0	--	2.0	300.0
Higher education, lecture series	--	--	17.5	--	--	--	--	--	35.0
Higher education, TV college	--	--	30.0	--	--	120.0	--	--	60.0
Higher education, continuing professional	--	--	10.6	--	--	--	--	--	58.0
Total	282.2	1,365.5	18,401.1	321.5	830.0	36,093.2		9.5	6,509.2

Table 1 (concluded)

ETV Application	Bolivia 1968	Bolivia 1972	Bolivia 1980	Chile 1968	Chile 1972	Chile 1980	Peru 1968	Peru 1972	Peru 1980
Adult education	--	4.0	75.0	--	--	--	--	28.0	125.0
Teacher training, preservice	--	--	12.0	--	--	40.0	--	--	16.0
Teacher training, inservice	--	--	1.4	--	6.0	4.5	--	--	4.4
Primary education, kindergarten	--	--	35.0	--	--	45.0	--	--	60.0
Primary education	--	--	1,412.5	--	--	6,250.0	9.1	22.5	12,500.0
Secondary education	--	--	120.0	--	--	1,500.0	--	--	1,500.0
Technical training	--	--	--	--	--	50.0	--	--	30.0
Higher education, science & math	--	--	--	--	--	150.0	--	--	37.5
Higher education, lecture series	--	--	--	--	--	17.5	--	--	--
Higher education, TV college	--	--	--	--	--	--	--	--	--
Higher education, continuing professional	--	--	2.0	--	--	8.4	--	--	10.0
Total		4.0	1,657.9		6.0	8,065.4	9.1	50.5	14,282.9

ETV Application	Uruguay 1968	Uruguay 1972	Uruguay 1980	Total 1968	Total 1972	Total 1980
Adult education	--	--	--	575.0	1,332.0	3,050.0
Teacher training, preservice	--	--	16.0	--	56.0	822.0
Teacher training, inservice	--	--	0.7	4.6	43.1	89.0
Primary education, kindergarten	--	--	25.0	27.0	120.0	1,790.0
Primary education	4.0	4.0	1,500.0	6,178.1	8,240.6	139,507.5
Secondary education	--	--	450.0	182.5	4,890.0	29,430.0
Technical training	--	--	--	39.0	117.5	526.0
Higher education, science & math	--	--	7.5	90.5	332.0	1,575.0
Higher education, lecture series	--	--	--	--	--	157.5
Higher education, TV college	--	--	--	--	--	255.0
Higher education, continuing professional	--	--	--	--	--	143.0
Total	4.0	4.0	1,999.2	7,096.7	15,131.2	177,329.0
Index				100.0	212.0	1,410.0

SYSTEMS COMPARISONS

Very preliminary designs of systems were prepared to provide the amounts of service responsive to the demand for ETV estimated for the next 12 to 20 years. For both India and Latin America, the following three distribution systems were designed:

- Microwave network linking ground-based stations
- Rebroadcast satellite linking ground-based transmitters
- Direct broadcast satellite linking ground transmitters with augmented television receiving sets

For Latin America, a fourth system was also designed:

- Truck or air shipment of video tapes linking groung-based stations.

The four distribution systems are illustrated in Figure 3. The alternative of video tape distribution was not considered for India, because it does not permit simultaneous national reception. Timeliness is not essential in school broadcasts, but news, public events, and other elements of a general communication service often must be timely to be effective. For India, another distribution system was examined:

- A combination of ground stations and direct broadcast from a satellite.

Table 2 is intended to summarize the performance of the four ETV distribution systems according to qualitative and quantitative criteria. A relative rating of excellent, good, fair, or poor has been assigned to

FIGURE 3

ALTERNATIVE ETV DISTRIBUTION MODES

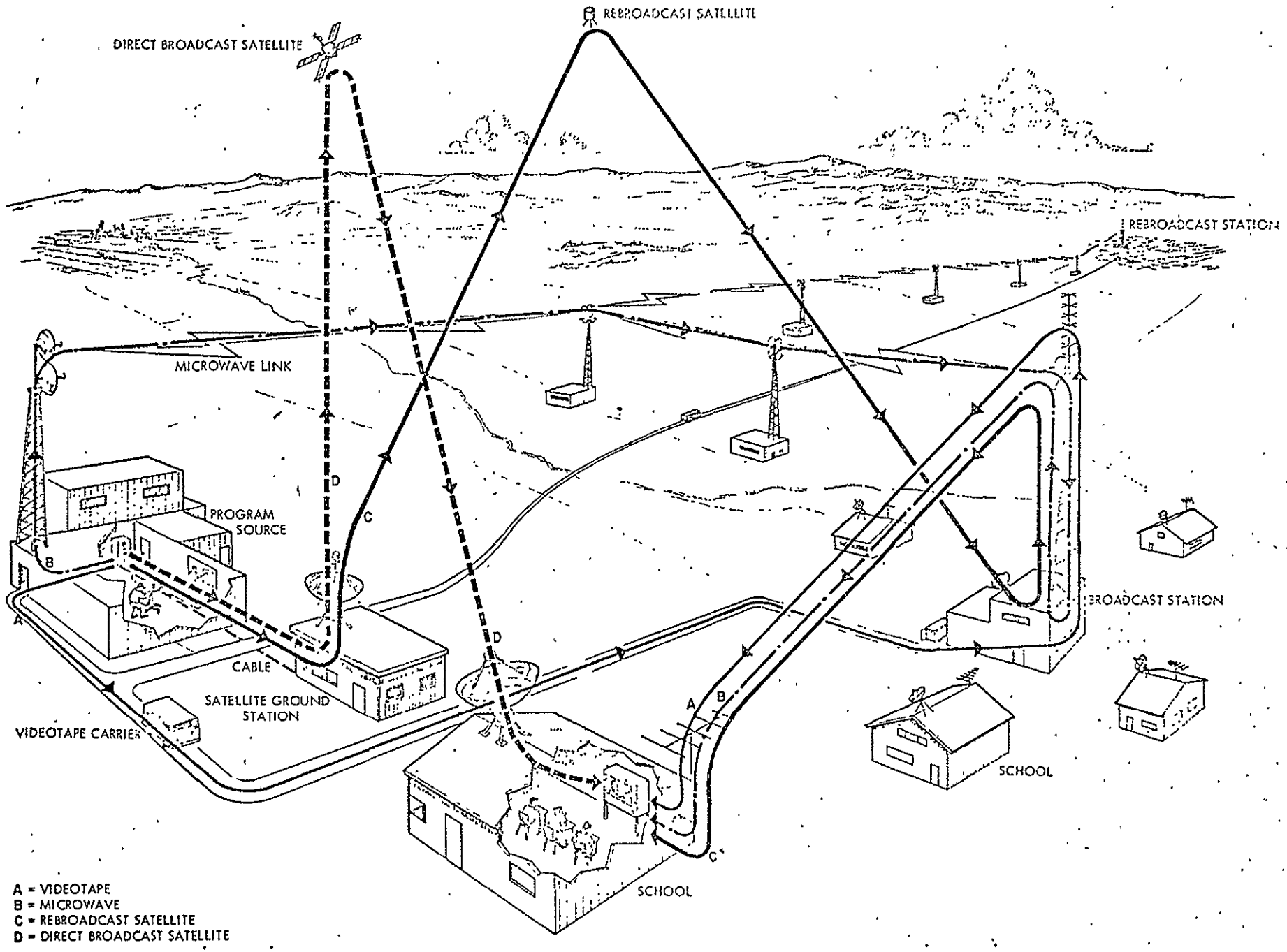

Table 2

RELATIVE PERFORMANCE OF ALTERNATIVE DISTRIBUTION SYSTEMS

Criterion	ETV Distribution System			
	Video Tape	Microwave	Rebroadcast Satellite	Direct Broadcast Satellite
Educational				
Ability to pace and control modernization	Poor	Good	Good	Excellent
Ability to reflect local programming needs	Excellent	Fair	Poor	Poor
Psychological impetus for modernization	Fair	Fair	Good	Excellent
Encouragement for multinational integration	Poor	Fair	Good	Excellent
Potential for growth in geographical coverage	Fair	Poor	Fair	Excellent
Simultaneous reception of important events	None	Good	Good	Excellent
Management				
Simplicity of local management	Poor	Fair	Fair	Good
Simplicity of central management	Good	Excellent	Fair	Fair
Adaptability to pilot tests of software	Excellent	Fair	Poor	Poor
Indirect Effects				
Spillover benefits for local communications	Good	Excellent	Good	Poor
Opportunity to develop local industries	Excellent	Good	Fair	Fair
Reliability				
Freedom from overall system interruption	Excellent	Good	Fair	Poor
Freedom from local failures	Poor	Fair	Fair	Good
Fiscal				
Cost of covering major urban centers	Excellent	Good	Fair	Poor
Cost of covering entire country	Fair	Poor	Poor	Good
Potential for major foreign assistance	Poor	Fair	Good	Good

signify the degree to which each system achieves the criterion noted. In the following paragraphs, the bases for the comparative ratings are discussed.

Ability to Pace and Control Modernization

ETV, however distributed, can be used as an instrument for reforming educational content and practices. Of the four alternative methods of distribution, those that are scheduled from the program source (for example, the nation's capital) provide more positive pacing and control than does the video tape distribution system, where the local television transmitting station broadcasts the program. Delays may occur in receiving tape from the program source. Some units of instruction may be omitted because local supervisors or teachers may be unfamiliar or insecure with the content. Thus, the video tape system does not offer pacing and control advantages inherent to the other distribution methods.

Of the centralized systems, the direct broadcast satellite was rated the highest on this criterion, because no administrative levels need intervene between program source and classroom.

Ability to Reflect Local Programming Needs

If local teachers are adequately prepared, a case can be made for allowing them flexibility in the pacing of instructional content. Here, the centralized distribution systems are at a disadvantage in relation to the video tape distribution made. The tape can be played at times most convenient to the majority of local teachers, and it can be replayed locally two or three times for remedial work or for students who missed the first showing. Of course, replay schedules are entirely possible with

the centralized systems too, but not with as great flexibility as for a locally scheduled station.

The microwave system has been given a slightly higher rating than the rebroadcast satellite, because the former has the potential to lead to the development of a more decentralized communications network and more nearly self-sufficient local television programming capability than the satellite-based system would. Television programming of local news or entertainment could be of assistance to local educational broadcasting.

Psychological Impetus for Modernization

The dramatic technology of satellite communication is more likely to capture the imagination of the people in a developing country and to implant the seeds of change than would the use of conventional technology. It can be speculated that the use of satellite technology could inspire teachers and students to make the needed break with traditional patterns. The direct broadcast satellite system was rated highest on this criterion, because the school's antennas would receive signals directly from the satellite instead of from an intermediary conventional television transmitter, thus heightening the sense of participating firsthand in advanced technology.

Encouragement for Multinational and Multicultural Integration

This criterion is related to the preceding one, in that the more localized systems of video tape or microwave distribution offer no technical imperatives for multinational or multicultural cooperation, whereas the wide coverage of satellite distribution systems requires at least technical and financial planning across national or cultural boundaries.

And technical and financial pooling may facilitate some sharing of educational content.

The four distribution systems can be rated on this criterion according to the degree to which each requires central pooling of programming efforts for economical and effective operations.

Potential for Growth in Geographical Coverage

On this criterion, the least satisfactory system is the microwave network, which requires the construction of expensive links whenever it is decided to extend the coverage. The video tape and rebroadcast systems are about equal on this count, requiring only that a new local television transmitter (or, for fringe areas, a signal booster) be established. The most flexible system, of course, is the direct broadcast satellite, where the signal can be brought into a school or a village located anywhere within the thousands-of-miles diameter coverage of the satellite, without waiting for the construction of intermediate transmitters. This capability alone has the potential to bring national coverage to rural and village populations years, perhaps decades, earlier than would be possible with alternative systems.

Simultaneous Reception of Live Events

The timeliness of live programs received simultaneously throughout a developing region is occasionally of importance in educational broadcasting and of great importance for news and political events in a general communication network. The video tape distribution system cannot offer any capability of this count, whereas the centralized systems can. The

direct broadcast satellite system was rated highest here, because simultaneous reception can be wherever receivers exist, whether or not a local television transmitter serves the area.

Simplicity of Local Management

Extensive video tape exchange represents a considerable local administrative burden. It is difficult to assure delivery of a large number of video tapes to subsidiary transmitting stations on time for use; yet if the time of delivery is set well in advance of use, the problems of storage and inventory are cumbersome. The local station must employ personnel who are skilled not only in inventory management and scheduling of these valuable tapes, but also in the operation and maintenance of a video tape recorder--valuable and sensitive equipment that must be carefully handled if it is to remain dependable and offer acceptable reception fidelity. Accordingly, the video tape system is rated the lowest on this criterion.

The centralized systems, where all scheduling is done at the source of programming, avoid the local administrative and logistical burden. On the other hand, both microwave and rebroadcast satellite systems require the management of local television broadcasting stations. Some specialized managerial and technical competence would be required.

The direct broadcast satellite system is rated highest of the four on this criterion, but even it requires operation and maintenance of a television receiver that has augmentation equipment necessary to receive and convert the signal directly from the satellite. Hence, it is given only a "good" rating.

Simplicity of Central Management

By this criterion, the satellite distribution systems, with their requirements for operating and maintaining complex earth stations and for keeping the satellite on station, rate lower than the terrestrial systems. Of the latter, the microwave network, once established, should be a good deal simpler to administer than the video tape exchange, which will require complex central and local management procedures for dispatching, receipt, storage, playing, replaying, and accounting for valuable video tape.

Adaptability to Pilot Tests of Software

Of the four systems, only that of video tape distribution lends itself easily to experimenting with educational braodcasting on a small scale at low cost to determine whether the technique offers important utility in comparisons with conventional instructional systems. The use of only one or two links in a microwave network could be considered a relatively modest pilot application, hence this system rates better than either of the satellite distribution methods. The satellite systems, with their enormous geographical coverage, tend to encourage all-or-none adoption, not pilot tests.

The above comments apply to situations in which the system is a single-purpose educational broadcasting system. If a telecommunications system, satellite or terrestrial, is available or is to be made available for other purposes, such as telephony or entertainment and news, it would be possible to conduct pilot tests of educational broadcasts on any of the four alternative distribution systems being compared. The organizers

of such pilot tests would not have to be concerned about the large unused geographical capacity of the satellite systems. They would, however, have to deal with a number of technical complexities associated with satellite communication that would not have to be faced in using more conventional terrestrial systems.

Spillover Benefits for Local Communications

In considering indirect effects, the ground-based systems offer greater spillover benefits in contributing to the growth of a communications infrastructure. The direct broadcast satellite is rated poor, because only the large and expensive transmitting ground station could be a source of broadcasting. In the other systems, local transmitters that would have alternative uses for local as well as central programming would be established.

Opportunity to Develop Local Industries

The satellite distribution systems include equipment of high technology that will probably continue to require foreign procurement. The terrestrially based systems, on the other hand, employ more nearly conventional technology. It can be expected that the electronics and construction industries of at least the larger developing countries like India, Brazil, and Mexico will continue to grow and will be able to account for an increasing share of initial and maintenance procurement of conventional telecommunications systems.

The video tape distribution system was rated the highest by this criterion, because it requires the most decentralized management. The

capability for managing this logistical system should have useful transfer to other local industrial management needs.

Any of the systems should encourage the building of a local or regional capability to manufacture receivers and service and maintain such equipment.

Freedom from Overall System Interruption

Satellite distribution systems are vulnerable to various kinds of interruption such as equipment faults at earth stations, drifting of the satellite off station, and satellite power failures. A satellite failure can result in the entire system being inoperable, which might pose severe readjustment strains on an educational system in which ETV had been integrated into curriculum. The direct broadcast satellite would be the most vulnerable to system failure, because no local television transmitters would be available for emergency programming of live or taped lessons.

Freedom from Local Failures

For the video tape system, which has the lowest rating on this criterion, the largest potential source of unreliability is the nonreceipt or misplacement of the particular video tape needed at a key time in the instructional sequence. The microwave and satellite distribution systems, where only one expert central crew controls the program scheduling, are less subject to local interruption than the video tape system, where less well-trained crews at each transmitting point increase the possibility of error. These systems are also subject to interruptions caused by failures of the local broadcasting station.

None of the television systems is rated higher than "good" on this criterion, because all are vulnerable to local power interruptions or voltage fluctuations--fairly common occurrences in developing countries.

Cost Comparisons

In Table 3, five alternative distribution systems for India are compared in terms of capital and operating costs. The system called "limited TV and local radio" was designed to cover 40 to 45 percent of India's population; the other four systems were designed to cover the 80 to 85 percent of population stated as a high priority objective by Indian leaders interviewed by the study team. Because Indian requirements call for a national television communication system with simultaneous reception, the alternative of video tape distribution is not included in the systems being compared. Of the systems studied, the direct broadcast satellite proved to be the least costly, followed by the combination of ground-based stations in the cities and direct satellite broadcasts to the villages.

The combined system seems particularly appropriate for helping to meet India's need for heterogeneity of language and cultural programming. The more local stations there are, the easier it will be to produce programs for specialized local needs. At the same time, the direct broadcast satellite can be a means of bringing television to the large number of remote villages decades sooner than would be possible with only a ground-based system.

It is not easy for anyone except the purchaser to say when a cost is too great, but costs of the combination system for India were compared

Table 3

FIVE TV DISTRIBUTION SYSTEMS FOR INDIA:
TOTAL CAPITAL AND OPERATING COSTS OVER 20 YEARS
AND AVERAGE COST PER YEAR
(Millions of Dollars)

System	Capital Costs		Operating Costs		Capital and Operating Costs	
	Total	Annual Average	Total	Annual Average	Total	Annual Average
Limited TV and local radio	$169.3	$ 8.5	$155.2	$ 7.5	$324.5	$16.0
Ground-based TV	442.4	22.1	313.4	15.7	755.8	37.8
Direct broadcast satellite	433.4	21.7	202.7	10.1	636.1	31.8
Rebroadcast satellite	456.5	22.8	266.3	13.3	722.8	36.1
Ground-based and direct broadcast satellite	436.5	21.8	240.9	12.9	677.4	33.8

with certain economic indicators. As Table 4 demonstrates, the annual cost, capital plus operating, is never likely to be much greater than 1 percent of the annual expenditure on education, or .07 of 1 percent of the national income.

With respect to the composition of expenditures on any of the proposed systems for India, analysis shows that the largest portion is spent on receivers--purchase, maintenance, and replacement. In the direct broadcast satellite system, for example, receivers represent about 75 percent of capital cost, satellites themselves only about 11 percent. Even in ground-based television, receivers represent about 50 percent of capital investment.

Table 5 presents the initial and operating costs of four alternative distribution systems designed to meet an estimate of Latin America's 1980 demand for ETV. As shown by the total costs for each of the three regions making up Latin America, the video tape system shows the lowest initial and operating costs, and the direct broadcast satellite system shows the highest costs. Microwave transmission and the rebroadcast satellite systems provide fairly interchangeable service. Where microwave networks are expected to be available, this system shows the lower cost of the two; where terrain and jungle are expected to delay the construction of microwave links, as in Peru, Bolivia, and Brazil, the rebroadcast satellite system shows lower costs.

The demand estimate on which Table 5 was based was primarily an urban demand, in which television service was extended in descending order of student concentrations. To test the effect of providing more nearly

Table 4

COMPARISONS OF ANNUAL COSTS OF A COMBINATION SATELLITE AND GROUND-BASED SYSTEM WITH ECONOMIC INDICATORS FOR INDIA, AT FIVE-YEAR INTERVALS

	1970-71	1975-76	1980-81	1985-86
National income (billions of dollars)	$37.5	$50.1	$67.1	$89.7
National expenditure on education (billions of dollars)	$1.3	$2.1	$3.3	$5.3
Annual cost of establishing and operating national television (billions of dollars)	$.0046	$.0193	$.046	$.0656
Education expenditure ÷ national income (percent)	3.4%	4.1%	5.0%	6.0%
Cost of national television ÷ national income (percent)	.012%	.039%	.069%	.073%
Cost of national television ÷ education expenditure (percent)	.35%	.91%	1.4%	1.2%

Table 5

LATIN AMERICAN ETV DISTRIBUTION SYSTEMS COSTS, 1980
(Thousands of Dollars)

Line	Cost Element	Central America: A Video Tape	Central America: B Microwave	Central America: C Rebroadcast	Central America: D Direct Broadcast	Served by One Satellite of 12 Video Channels: Mexico A Video Tape	Mexico B Microwave	Mexico C Rebroadcast	Mexico D Direct Broadcast	Colombia A Video Tape	Colombia B Microwave	Colombia C Rebroadcast	Colombia D Direct Broadcast	Venezuela A Video Tape	Venezuela B Microwave	Venezuela C Rebroadcast	Venezuela D Direct Broadcast	Total A Video Tape	Total B Microwave	Total C Rebroadcast	Total D Direct Broadcast	Served by One Satellite: Brazil A Video Tape	Brazil B Microwave	Brazil C Rebroadcast	Brazil D Direct Broadcast
	Initial Costs:																								
1.	Broadcast stations total	$ 8,034	$ 8,034	$ 8,034	$ n.a.	$ 4,646	$ 4,646	$ 4,646	$ n.a.	$ 9,273	$ 9,273	$ 9,273	$ n.a.	$6,894	$ 6,894	$ 6,894	$ n.a.	$32,847	$32,847	$32,847	$ n.a.	$12,382	$12,382	$12,382	$ n.a.
2.	Broadcast stations, main	n.a.	n.a.	n.a.	8,034	n.a.	n.a.	2,680	n.a.	n.a.	n.a.	n.a.	1,752	n.a.	n.a.	n.a.	1,239	n.a.	n.a.	n.a.	13,805	n.a.	n.a.	n.a.	4,430
3.	Microwave	n.a.	2,669	n.a.	n.a.	3,149	n.a.	n.a.	n.a.	n.a.	3,089	n.a.	n.a.	n.a.	3,909	n.a.	n.a.	n.a.	12,816	n.a.	n.a.	n.a.	24,223	n.a.	n.a.
4.	Satellite and launch {I	n.a.	n.a.	3,000	7,850	n.a.	3,060	7,970	n.a.	n.a.	n.a.	3,480	9,080	n.a.	n.a.	2,920	7,600	n.a.	n.a.	12,460	32,500	n.a.	n.a.	12,446	36,730
5.	II	n.a.	n.a.	n.a.	6,050	n.a.	n.a.	6,130	n.a.	n.a.	n.a.	n.a.	7,020	n.a.	n.a.	n.a.	5,900	n.a.	n.a.	n.a.	25,100	n.a.	n.a.	n.a.	n.a.
6	Ground stations, transmitting	n.a.	n.a.	3,810	3,810	n.a.	1,280	1,280	n.a.	n.a.	n.a.	610	610	n.a.	n.a.	610	610	n.a.	n.a.	5,400	5,400	n.a.	n.a.	1,820	1,820
7.	Ground stations, receiving	n.a.	n.a.	0	n.a.	n.a.	2,192	n.a.	n.a.	n.a.	n.a.	2,660	n.a.	n.a.	n.a.	3,192	n.a.	n.a.	n.a.	9,014	n.a.	n.a.	n.a.	3,370	n.a.
8	Tape library - total	475	n.a.	n.a.	n.a.	460	n.a.	n.a.	364	n.a.	n.a.	n.a.	n.a.	345	n.a.	n.a.	n.a.	1,704	n.a.	n.a.	n.a.	574	n.a.	n.a.	n.a.
9.	Tape library - main	n.a.	410	410	410	436	436	436	n.a.	248	248	248	248	n.a.	208	208	208	n.a.	1,302	1,302	1,302	n.a.	260	260	260
10	Studios and equipment	800	800	800	800	1,067	1,067	1,067	1,334	1,334	1,334	1,334	1,334	534	534	534	534	3,735	3,735	3,735	3,735	1,067	1,067	1,067	1,067
11.	Receivers	1,890	1,890	1,890	1,400	1,550	1,550	1,550	3,340	1,340	1,340	3,340	3,310	1,910	1,910	1,910	3,910	8,490	8,490	8,490	8,490	3,150	3,150	3,150	3,150
12.	Additions to receivers {I	n.a.	n.a.	n.a.	10,430	n.a.	n.a.	7,630	n.a.	n.a.	n.a.	n.a.	18,900	n.a.	n.a.	n.a.	10,810	n.a.	n.a.	n.a.	48,010	n.a.	n.a.	n.a.	21,300
13	II	n.a.	n.a.	n.a.	5,400	n.a.	n.a.	4,708	n.a.	n.a.	n.a.	n.a.	11,610	n.a.	n.a.	n.a.	6,683	n.a.	n.a.	n.a.	27,973	n.a.	n.a.	n.a.	11,000
14.	Total {I	$11,199	$12,803	$17,974	$33,514	$11,303	$14,646	$19,031	$22,403	$14,351	$17,284	$10,975	$32,291	$9,723	$13,455	$16,298	$23,041	$48,778	$58,190	$71,278	$114,252	$17,173	$43,087	$36,447	$49,477
15.	II	$ n.a.	$ n.a.	$ n.a.	$39,468	$ n.a.	$ n.a.	$17,681	$ n.a.	$ n.a.	$ n.a.	$24,014	$ n.a.	$ n.a.	$ n.a.	$ n.a.	$17,218	$ n.a.	$ n.a.	$ n.a.	$ 69,369	$ n.a.	$ n.a.	$ n.a.	$38,477
	Operating Costs																								
16.	Broadcast station	1,200	1,200	1,200	1,400	1,600	1,600	1,600	400	1,200	1,200	1,200	800	1,400	1,400	1,400	800	5,400	5,400	5,400	3,000	2,400	2,400	2,400	600
17	Microwave	n.a.	400	n.a.	n.a.	437	n.a.	n.a.	n.a.	n.a.	431	n.a.	n.a.	n.a.	544	n.a.	n.a.	n.a.	1,789	n.a.	n.a.	n.a.	3,321	n.a.	n.a.
18	Satellite and launch {I	n.a.	n.a.	623	1,370	n.a.	630	1,410	n.a.	n.a.	723	1,690	n.a.	n.a.	600	1,300	n.a.	n.a.	n.a.	2,000	3,870	n.a.	n.a.	2,900	4,240
19.	II	n.a.	n.a.	354	240	n.a.	474	80	n.a.	n.a.	356	40	n.a.	n.a.	415	40	n.a.	n.a.	n.a.	1,600	400	n.a.	n.a.	700	300
20	Ground station	7	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	4	n.a.	n.a.	n.a.	n.a.	4	n.a.	n.a.	n.a.	11	n.a.	n.a.	n.a.	17	n.a.	n.a.	n.a.
21.	Tape transport	35	6	6	6	41	6	6	35	6	6	6	35	4	4	6	5	146	16	16	16	16	4	6	6
22.	Tape library	1,450	1,450	1,450	1,450	1,580	1,480	1,280	2,236	2,236	2,236	2,236	2,236	1,513	1,513	1,513	1,813	6,779	6,779	6,779	6,779	2,404	2,904	2,904	2,904
23.	Program production, teacher training and maintenance	n.a.	n.a.	n.a.	468	n.a.	n.a.	334	n.a.	n.a.	n.a.	n.a.	630	n.a.	n.a.	n.a.	479	n.a.	n.a.	n.a.	2,100	n.a.	n.a.	n.a.	700
24.	Maintenance of feasible additions	n.a.	n.a.	n.a.	468	n.a.																			
	Total	$ 2,692	$ 3,056	$ 3,833	$ 4,334	$ 3,828	$ 3,403	$ 4,310	$ 3,813	$ 3,473	$ 3,873	$ 4,833	$ 4,302	$ 2,948	$ 4,660	$ 3,854	$ 3,534	$13,546	$15,986	$18,397	$ 16,867	$ 5,882	$ 9,031	$ 8,608	$ 8,596

Note: n.a = not applicable.

Table 5 (concluded)

Line	Cost Element	Served by One Satellite of 13 Video Channels																							
		Argentina				Bolivia				Chile				Peru				Uruguay				Total			
		A Video Tape	B Microwave	C Rebroadcast	D Direct Broadcast	A Video Tape	B Microwave	C Rebroadcast	D Direct Broadcast	A Video Tape	B Microwave	C Rebroadcast	D Direct Broadcast	A Video Tape	B Microwave	C Rebroadcast	D Direct Broadcast	A Video Tape	B Microwave	C Rebroadcast	D Direct Broadcast	A Video Tape	B Microwave	C Rebroadcast	D Direct Broadcast
	Initial Costs																								
1.	Broadcast station total	$ 8,059	$ 9,058	$ 8,058	$ n.a.	$3,651	$ 3,651	$ 3,651	$ n.a.	$6,445	$ 6,445	$ 6,445	$ n.a.	$ 7,949	$ 7,949	$7,949	$ n.a.	$1,832	$1,832	$ 1,832	$ n.a.	$28,936	$26,930	$28,936	$ n.a.
2.	Broadcast station, main	n.a.	n.a.	n.a.	1,339	n.a.	n.a.	n.a.	926	n.a.	n.a.	n.a.	1,339	n.a.	n.a.	n.a.	1,339	n.a.	n.a.	n.a.	926	n.a.	n.a.	n.a.	5,669
3.	Microwave	n.a.	16 309	n.a.	n.a.	n.a.	2 439	n.a.	n.a.	n.a.	4,250	n.a.	n.a.	n.a.	14,379	n.a.	n.a.	n.a.	634	n.a.	n.a.	n.a.	44,178	n.a.	n.a.
4.	Satellite and launch (i)	n.a.	n.a.	2,134	4,216	n.a.	n.a.	1 967	2,677	n.a.	n.a.	2,713	3,490	n.a.	n.a.	3,190	1,067	n.a.	n.a.	2,200	3,093	n.a.	n.a.	12,413	16,718
	(ii)	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
5	Ground stations, transmitting	n.a.	n.a.	610	610	n.a.	n.a.	610	610	n.a.	n.a.	610	610	n.a.	n.a.	610	610	n.a.	n.a.	610	610	n.a.	n.a.	3,100	3,100
6	Ground stations, receiving	n.a.	n.a.	1,326	n.a.	n.a.	n.a.	3,549	n.a.	n.a.	n.a.	3,640	n.a.	n.a.	n.a.	3,724	n.a.	n.a.	n.a.	532	n.a.	n.a.	n.a.	13,032	n.a.
7	Tape library - total	378	n.a.	n.a.	n.a.	241	n.a.	n.a.	n.a.	252	n.a.	n.a.	n.a.	418	n.a.	n.a.	n.a.	195	n.a.	n.a.	n.a.	1,111	n.a.	n.a.	n.a.
8	Tape library - main	n.a.	206	206	206	n.a.	132	132	132	n.a.	180	180	180	n.a.	328	128	182	n.a.	181	181	181	n.a.	221	221	221
9.	Studios and equipment	800	800	800	800	534	534	534	534	800	800	800	800	534	534	534	534	534	534	534	534	2,902	2,902	2,902	2,902
10	Receivers	773	773	773	773	216	216	216	216	810	810	810	810	1,410	1,410	1,410	1,410	164	164	164	164	3,194	3,194	3,194	3,194
11.	Additions to receivers (i)	n.a.	n.a.	n.a.	7,728	n.a.	n.a.	n.a.	2,184	n.a.	n.a.	n.a.	9,200	n.a.	n.a.	n.a.	14,312	n.a.	n.a.	n.a.	1,014	n.a.	n.a.	n.a.	34 438
	(ii)	n.a.	n.a.	n.a.	2,700	n.a.	n.a.	n.a.	760	n.a.	n.a.	n.a.	3,707	n.a.	n.a.	n.a.	4,828	n.a.	n.a.	n.a.	373	n.a.	n.a.	n.a.	11,168
12.	Total (i)	$11,218	$26,146	$14,847	$13,701	$4,610	$11 154	$ 9 424	$ 7,311	$8,437	$13,685	$14,147	$16,769	$10,331	$26,315	$16,699	$21,378	$3,746	$3,331	$ 6,153	$ 7,161	$37 332	$80 481	$63,949	$66,321
	(ii)	$ n.a.	$ n.a.	$ n.a.	$10,678	$ n.a.	$ n.a.	$ n.a.	$ 3,687	$ n.a.	$ n.a.	$ n.a.	$10,771	$ n.a.	$ n.a.	$ n.a.	$13,081	$ n.a.	$ n.a.	$ n.a.	$ 2,070	$ n.a.	$ n.a.	$ n.a.	$30,168
	Operating Costs																								
16	Broadcast station	1,100	1,100	1,100	500	1 200	1,200	1,200	700	1,200	1,200	1 200	500	1,600	1,600	1,600	800	400	400	400	200	6,200	6,200	6 200	1,800
17	Microwave	n.a.	2,342	n.a.	n.a.	n.a.	963	n.a.	n.a.	n.a.	357	n.a.	n.a.	n.a.	3,937	n.a.	n.a.	n.a.	17	n.a.	n.a.	n.a.	8,335	n.a.	n.a.
18.	Satellite and launch	n.a.	n.a.	440	1,080	n.a.	n.a.	430	690	n.a.	n.a.	330	330	n.a.	n.a.	470	780	n.a.	n.a.	470	780	n.a.	n.a.	2,600	4,260
19.	Ground station	n.a.	n.a.	120	60	n.a.	n.a.	239	60	n.a.	n.a.	330	60	n.a.	n.a.	458	60	n.a.	n.a.	116	60	n.a.	n.a.	1,000	300
20.	Tape transport	9	n.a.	n.a.	n.a.	2	n.a.	n.a.	n.a.	7	n.a.	n.a.	n.a.	7	n.a.	n.a.	n.a.	1	n.a.	n.a.	n.a.	32	n.a.	n.a.	n.a.
21	Tape library	23	6	6	6	33	3	6	6	33	6	6	6	47	6	6	6	33	3	6	6	176	30	30	30
22	Program production, teacher training, net maintenance	1,246	1,246	1,246	1,246	456	459	456	456	970	970	970	970	1,021	1,021	1,021	1,021	771	771	771	771	4,715	4,715	4,715	4,715
	Maintenance of receiver additions	n.a.	n.a.	n.a.	137	n.a.	n.a.	n.a.	50	n.a.	n.a.	n.a.	211	n.a.	n.a.	n.a.	324	n.a.	n.a.	n.a.	36	n.a.	n.a.	n.a.	608
24.	Total	$ 2,306	$ 3,681	$ 2,232	$ 2,749	$1,936	$ 2,649	$ 2,641	$ 1,706	$2,211	$ 2,738	$ 2,301	$ 2,108	$ 2,675	$ 5,561	$ 3,563	$ 2,391	$1,264	$1,191	$ 1,783	$ 1,848	$11,314	$19,300	$15,341	$11,181

Note: n.a. = not applicable

total national coverage, a special study was made of one country, Colombia, using a higher demand estimate for 1980, in which all Colombian cities and towns of over 10,000 population would be reached. Costs were recalculated for the video tape and the direct broadcast satellite distribution systems. Total initial costs for Colombia became $30 million for the video tape system, versus $28 million for the direct broadcast satellite system. The direct broadcast satellite thus replaces the video tape system as the least expensive system, largely because the cost of procuring television sets augmented to receive the satellite signal becomes less than the cost of constructing local television transmitters that reach relatively few students. The direct broadcast satellite system also showed lowest operating costs for the assumption of full national coverage of Colombia.

Table 6 presents the initial and operating costs of two methods of meeting the projected 1980 ETV demand for the countries studied in Latin America. To simplify the table, only the direct broadcast satellite and video tape systems were compared. Examination of the dollar cost columns shows that the satellite system makes initial and operating cost savings in broadcast stations, but that these are more than offset by costs of satellite and launch and of the television set augmentations required to receive the signal directly from the satellite. The cost of set augmentations is highly sensitive to quantity procured. If substantially more than the 75,000 sets on which this calculation was based were to be procured, this initial cost element would be considerably reduced.

The percentage distribution column in Table 6 is informative on how funds would have to be spent for either distribution system. In the video tape system, the bulk of initial expenditures is on broadcast stations

Table 6

COSTS OF TWO ETV
DISTRIBUTION SYSTEMS TO MEET 1980 DEMAND:
LATIN AMERICAN TOTALS AND PERCENT DISTRIBUTION BY COST ELEMENT

	Video Tape System		Direct Broadcast Satellite System	
	$000	%	$000	%
Initial Costs				
Broadcast stations	$ 74,185	73.2%	$ 24,104	14.1%
Satellite and launch	n.a.	n.a.	58,600	33.9
Ground stations	n.a.	n.a.	11,420	6.6
Tape library	3,989	3.9	2,383	1.4
Studios and equipment	8,004	7.9	8,004	4.7
Receivers	15,124	15.0	15,124	8.8
Additions to receivers	n.a.	n.a.	52,833	30.5
Total	$101,302	100.0%	$172,468	100.0%
Operating Costs (Annual)				
Broadcast stations	$ 14,200	48.9%	$ 3,600	9.8%
Satellite and launch	n.a.	n.a.	14,230	38.7
Ground stations	n.a.	n.a.	900	2.4
Tape transport	65	0.2	n.a.	n.a.
Tape library	398	1.4	54	0.1
Program production, teacher training, and set maintenance	14,394	49.5	14,394	39.2
Maintenance of receiver additions	n.a.	n.a.	3,600	9.8
Total	$ 29,057	100.0%	$ 36,778	100.0%

Note: n.a. = not applicable.

and studios and their equipment, whereas in the direct broadcast satellite system, the largest items are for the satellite and launch and for procuring set augmentations. With respect to operating costs, the items of program production, teacher training, and set maintenance are important for both distribution systems, but in the satellite system operating funds must be set aside for successive launches every three to five years to maintain the communications capability.

The quantity of sets to be procured was almost a million in India and less than 100,000 in Latin America. Aside from the differences in the size of populations to be served, this is because only 6,000 sets are in use in India, while six million are already in use in Latin America. The difference in procurements explains much of the variation in percentage distributions of costs for the two case regions.

The following conclusions can be drawn from the several analyses made for India and Latin America:

- Video tape distribution is the least-cost system up to a high degree of saturation of urban schools.
- The direct broadcast satellite system becomes the least-cost system for population residing beyond the range of transmitters located in principal cities.
- If ETV is extended to student populations in ascending order of cost per student served, the breakeven point at which the direct broadcast satellite begins to be more cost-effective than video tape distribution lies between 35 and 60 percent of total country population, the particular point being

dependent on population distribution and the presence or absence of television transmitters in outlying areas.

- Of the four distribution systems, only the direct broadcast satellite system exhibits declining unit cost per student served with increasing coverage. The other systems exhibit rising unit costs after the population residing in large and medium-sized cities and other densely populated areas has been served.

Potential for Major Foreign Assistance

With the predisposition of multilateral and bilateral donors to favor large scale technologically based assistance programs, it would appear that the satellite distribution systems might have somewhat better prospects of attracting assistance grants or loans than would the more conventional distribution systems.

A NOTE TO PROSPECTIVE USER COUNTRIES

On the basis of these studies, the research team prepared suggestions for officials of countries or regions who are considering a major expansion of television, with or without satellites, for education and development. Briefly, the following procedure would seem advisable:

- Begin with needs, rather than with technology. The important question is whether the need to expand or upgrade instruction and information is sufficient to justify a major system development. The system should grow out of the priority needs and be tailored to meet them.
- Begin with television, rather than with satellites. The question is, can television make a significant contribution to the country's educational and development needs?
- If so, compare different systems for delivering television. Develop these systems in some detail, including some sample programming, a phasing of expansion, and an inventory of the economic, human, and technical resources that would be required. In particular, do not forget to look at systems that combine more than one method of delivery--especially the combination of ground-based and satellite television.
- Study the heterogeneity problem carefully. How can the system best be designed to meet both regional and local needs? Here, combined systems may prove especially attractive.

- Survey the resources. What will be required for development of an electronics industry, engineering and technical personnel, broadcasting personnel, extension of electric power, transportation, and teacher training? If these are not available in sufficient quantities, how can they be provided?

- Try to solve, at the beginning, the problem of organization and control. This is discussed at some length in the India case study, and it has proved to be a serious problem in numerous countries. Briefly, a major television system, with thousands of employees, requires both freedom to be creative and close contact with the substantive agencies that should participate. What is the best assignment of organizational responsibilities for these two purposes, and how should the assignment relate to the control system of government?

- Plan, if possible, a gradual expansion of the system, one step at a time. If the job is to be done thoroughly, a period of several years will be needed for: detailed planning; hiring and training; manufacture of receivers and other electronic gear; construction of stations; work on content and curriculum, scheduling, making, and testing of programs; and practice in using the new system. If time is allowed for these tasks, there will be fewer problems, fewer mistakes in the first years, and less chance for a failure. If the development is gradual and measured, the cost can be spread out more evenly, the experience and skills gained in early stages can be utilized in later stages, mistakes can be corrected, and formidable problems can be mastered before they affect an entire

system. Ideally, the plan should be developed so that at any given stage it is possible to take stock and decide on the next step.

POLICY IMPLICATIONS FOR THE UNITED STATES

No intimate knowledge was available to the study teams regarding policy issues the United States government faces in satellite communication and in development assistance for India and Latin America. Nevertheless, on the basis of the case studies, the following suggestions are offered:

- Conserve resources vital to satellite communication systems. A need for three satellites, each with 12 video channels, has been projected to meet the 1980 educational requirements of Latin American countries. These would be in addition to the INTELSAT requirements for an Atlantic service, the domestic satellite needs of the United States (perhaps four satellites), the domestic satellite needs of Canada (now estimated at three satellites), and military needs. The estimate of one satellite for India is more modest and, indeed, may be too modest.

  Planning for satellite communications calls attention to the limited availability of frequency spectrum and of "parking slots" in space for synchronous satellites. These are world resources, and it is hoped that the policy of the United States government will be to conserve the necessary part of such resources for human resources development. International reallocation of frequencies and a basic scheme for assigning satellite "parking slots" may be required.

- Build competence in educational and developmental television. Television for human resources development will be as effective as the kind of resources--human, technical, and economic--that are put into it. High priority should be given requests for assistance in training and retraining of teachers, broadcasters, planners, and development personnel to become familiar with and skilled in the use of television for education and development. Most of such training, of course, need not and should not be given in the United States. It should be the policy of the United States to support a limited number of excellent demonstration projects in the use of television. A project such as the program now being instituted by the government of El Salvador, with U.S. assistance, can do more to advance the potential of human resources television than a number of instances of small support to less well-planned projects. Finally, existing U.S. policy to support regional integration and cooperation in education is of great importance in making feasible the cooperative use of human resources television, whether terrestrial or by satellite. Examples of points of leverage for this purpose in Latin America are programs for intercountry harmonizing of curriculum and textbooks, implementation of the planned OAS training center in ETV, and exchange of educators and broadcasters.
- Give priority to requests from developing countries for assistance in training and retraining teachers to become effective in an instructional system of which ETV is an integral part. As an example, the training technique of microteaching is useful in

meeting the dual objectives of modernizing pedagogy and orienting teachers to the power of the television medium.

- Build from strength. The aid policy of the United States in the area of developmental television and satellite educational systems should make maximum use of the extraordinary experience and resources of the United States in such areas as instructional broadcasting, space science, development planning, and social research. Much training might well be built around relatively successful projects, such as that in Samoa, Colombia, and El Salvador, all accomplished with U.S. assistance. The experience of developing regions with these new technologies should be studied carefully and reported widely, on film and on paper. In the United States, there has been probably more experience with video tape exchange (which is treated at length as an element of Latin American systems) than anywhere else in the world. Microteaching, one of the most promising devices for training teachers, has been developed here. And much of the work on communications satellites has been done here. It is worth considering what sorts of centers or other organizations in this country or elsewhere might best make some of these resources available where they can do the most good in human resources development.

- Plan software for ETV systems. One of the greatest bottlenecks in developing satellite-based television systems is likely to be the absence of planning for the software needs of these systems. In Latin America, it was necessary for the project team to make the

demand estimates included in this report with entirely insufficient information, because projections by Latin Americans had not been made. Despite India's long tradition of planning, there was very little in existence that could be put immediately to use if the country were to decide to take up a satellite-distribution system. The important step in planning at this moment is not to repeat hardware-oriented planning studies that make gross and unwarranted assumptions about educational applications, but rather to look critically and in detail at possible educational and developmental applications of the broadcast media. Therefore, the policy of the United States should be to look favorably on requests for assistance in planning and organizing the software aspects of satellite systems.

- Encourage pilot projects. The proposed cooperation between NASA and INCOSPAR in arranging for a satellite to be made available to India for a limited period of experimentation will be useful in working out some of the hardware, maintenance, programming, and administrative questions of satellite broadcasting. This cooperation will be generally stimulating to plans for satellite systems. It seems that there is good reason for other pilot projects, especially in regions where there is a good chance of developing major satellite television systems for human resources development. For example, if it were possible to obtain another satellite under similar arrangements, particularly one having rudimentary direct broadcast capability, it might be beneficial to offer Latin Americans the chance to try it out for a time. The terms of the

offer should include provision for multinational cooperation and for Latin American countries to plan and manage the program. Needless to say, assistance and advice should be made available to such projects so that as much as possible can be learned from them and these lessons can be made widely known.

- Support research on critical problems influencing effectiveness and cost. Considering the probable usefulness of direct broadcast satellites and their interesting growth potential for large scale coverage, it would be useful to direct some research toward minimizing the system cost represented by the necessary augmentation of receivers for direct reception--that is, the antenna, pre-amplifier, and feed--particularly for production in quantities between 10,000 and 200,000.