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ABSTRACT

This report documents a research project focusing on the role of telecommunications technology in the regional delivery of educational services, including assessment of needs, factors in choosing the technology for implementation, alternative delivery systems, cost analysis, and a study of possible demonstration projects in South Carolina, Alabama, and Georgia. Detailed cost figures for various instructional television delivery systems are provided in charts, tables, and models. The representative case studied in detail was the delivery of both vocational education services and general educational services to the Appalachian States. Various instructional television delivery systems were compared and consideration given to the need for local replay and production capability. Instructional television can deliver course material to a large general education audience and to the dispersed and specialized vocational education audience simultaneously, with the combined cost comparable tc teacher delivery of general education courses alone. It was found that satellite direct reception is the least expensive system. Video tape replay capabilities could provide flexibility at reasonable cost. Additional studies are recommended on a range of topics important for understanding the role of telecommunications in the regional delivery of health, education, and welfare services. (MF)

THE ROLE OF TELECOMMUNICATIONS IN THE REGIONAL DELIVERY OF EDUCATION SERVICES: A STUDY OF THE POTENTIAL USE OF INSTRUCTIONAL TELEVISION FOR VOCATIONAL EDUCATION IN THE APPALACHIAN STATES

INTASA, INC.

BATTELLE - COLUMBUS

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THE ROLE OF TELECOMMUNICATIONS IN THE REGIONAL DELIVERY OF EDUCATION SERVICES: A STUDY OF THE POTENTIAL USE OF INSTRUCTIONAL TELEVISION FOR VOCATIONAL EDUCATION IN THE APPALACHIAN STATES

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November, 1972

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November 28, 1972

Dr. Albert L. Horley
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U.S. Department of Health,
Education, and Welfare
Washington, D.C. 20203

Dear Dr. Horley:

Enclosed are 15 copies of our final report which presents the research results from the joint efforts of several individuals at Battelle's Columbus Laboratories, INTASA, Inc., and myself who have completed this initial investigation into "The Role of Telecommunications in the Regional Delivery of Education Services". The Project Summary (Chapter 1) provides a brief statement of the major findings and conclusions presented in the remaining chapters of the report.

We wish to thank you and your staff for the opportunity of working with the Office of Telecommunications on this program, and look forward to a continuing relationship with your office in the future.

Sincerely,

William K. Linvill

William K. Linvill
Project Director

WKL/bmc

Enc.

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We wish to thank Dr. Albert Horley, Director of the Office of Telecommunications, HEW, for his support as administrator of the contract. Dr. Bruce Lusignan of the Office of Telecommunications deserves a special measure of appreciation for his direction of the structuring and development of th analysis, and his supportive monitoring of our efforts as the study progressed.

We can only express our thanks in general to all the individuals in and out of the Federal government who took time to assist us with information necessary for the study.

CONTRIBUTIONS OF PROJECT STAFF

This report documents the efforts of W.K. Linvill, Project Director, INTASA, Inc., and Battelle's Columbus Laboratories to assess the role of telecommunications in the regional delivery of education services.

Dr. W.K. Linvill was responsible for coordinating and integrating the technical efforts of INTASA and Battelle. In addition, he provided specific direction in several areas of the study, contributed to the development of vocational education program schemes for Chapter V, wrote Appendix C, and assisted in the development of the conclusions and recommendations of the study (Chapter I).

INTASA was responsible for selecting the focus of vocational education in the Appalachian states and for the analysis of technological capabilities in the delivery of instruction. This work is contained in Chapters I to VI and Appendices A and B. In particular, Dr. L.T. Brekka was responsible for the structure of the analysis and the assessment of the educational functions performed by the instructional television systems. He was also responsible for reviewing the status of computer technology. Dr. C.H. Jolissaint was responsible for the assessment of the integration of telecommunications systems with the delivery of educational services, the extensive cost analysis of those systems, and the development of implications for local school control of schedules and program productions.

Professor D.A. Dunn assisted in the formulation of alternative telecommunications systems, the assessment of their potential effectiveness, and contributed to the development of conclusions and recommendations.

Battelle was responsible for the development of representative demonstrations of vocational education and health care delivery via telecommunications. A possible pilot project to apply telecommunications to vocational education in health occupations in Alabama, and a project for health care delivery in South Carolina are developed in Chapter VII. Mr. R.M. Davis of Battelle directed the development of the representative demonstrations. Mr. R.A. Forster was responsible for the Alabama demonstration model. Mr. R.R. Kessler and Mr. R.G. Bowman developed the South Carolina model demonstration plan.

Chapter I

PROJECT SUMMARY

A. Background

An unsolicited proposal was submitted by Battelle Columbus Laboratories, with INTASA, Inc. as subcontractor, to the Office of Telecommunications, Department of Health, Education and Welfare, on April 24, 1972. Contract No. HEW-05-72-163 was awarded on June 5, 1972. The study was designed to assist the Office of Telecommunications in its role of providing direction to the Secretary of Health, Education and Welfare in developing social service programs utilizing telecommunications. Attention was to be focused on the role of telecommunications in the regional delivery of an educational service.

B. Project Organization

The work was apportioned between INTASA, Inc. and Battelle Columbus Laboratories as follows:

1. Dr. W.K. Linvill was responsible for coordination of the work of Battelle and INTASA, and for the integration of the results of the two efforts.

2. INTASA was responsible for structuring the analysis and assessing the capabilities of telecommunications technology in the delivery of a representative educational service. Drs. L.T. Brekka and C.H. Jolissaint were responsible for INTASA's work.

3. Battelle Columbus Laboratories was responsible for assessing local needs in the Appalachian region and identifying potential demonstrations of education and health services delivered via telecommunications. Mr. R.M. Davis managed the overall contract and led the Battelle work. R.A. Forster and R.R. Kessler developed demonstration proposals with contributions from R.G. Bowman.

C. Scope of Work Conducted

This study has primarily focused on assessment of the use of telecommunications in the delivery of educational services. Because of the maturity of the technology for instructional television (ITV), that technology has been emphasized.

The use of computer-aided instruction (CAI) is considered promising but not yet operationally mature. Research programs in this area are reviewed briefly. The use of computer-managed instruction (CMI) is presently feasible but does not require any substantial joint planning effort so it was not studied in detail.

A model for the costs of various delivery systems for instructional television was developed which allows alternatives to be compared easily. Hardware costs, costs of administration and coordination, and programming costs were combined.

Cost models were developed for the following:

1. For long-haul transmission, both satellite systems and point-to point microwave transmission were assessed.
2. For local delivery systems, cable, instructional television fixed service* (ITFS) and direct satellite were assessed.
3. All combinations of transmission, distribution, and local video tape recording (VTR) systems were studied.
4. Costs were estimated for distribution inside schools.
5. Costs of administration and coordination of systems were assessed.
6. Cost estimates for programming were reviewed and summarized.
7. The value of teacher time saved was estimated.

The representative case studied in detail was the delivery of vocational education services along with the delivery of general educational services to the Appalachian states. Various ITV delivery systems were compared and consideration given to the need for local replay and production capability. Special emphasis was placed on assessing the flexibility for scheduling provided by local video tape recording (VTR) in conjunction with local distribution networks utilizing either cable or local video broadcast using instructional television fixed service (ITFS).

All of the evaluations of present systems show that local acceptance by teachers, students, and the community is necessary for such a system to develop successfully. The development of local plans for demonstration projects

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* The instructional television fixed service facility is a broadcast facility in the 2500 to 2690 MHz range (above the UHF television band). It has a four channel capacity limit imposed by law and about 10-20 mile range. For more characteristics refer to page 44 in this report.

involving a local community advocate who could stimulate joint action by Federal, State, and local public agencies and the local community leaders and citizens appears to improve greatly the chances for success of the implementation of an ITV system. Several specific representative examples are developed.

The use of telecommunications to deliver health and welfare services was surveyed briefly and the combination of ITV in delivery of health occupation education (HOE) and the use of telecommunications to support health care delivery in rural areas with dispersed populations appears to be a promising demonstration project opportunity.

D. Conclusions

1. ITV Simultaneous Delivery of Vocational and General Education

To be useful, vocational education must be highly specialized. In rural Appalachia, the need is for many programs of small individual enrollment, highly dispersed. Delivery of such courses is necessarily expensive, prohibitively so if done solely by individual teachers to rigorous quality standards. In order to reduce the cost and maintain quality, ITV can be introduced. It can deliver course material to a large general education audience over all thirteen States and to the dispersed and specialized vocational education audience simultaneously. Several advantages result: The dispersed rural students receive high-quality vocational education courses and high-quality general education courses. Substantial saving in teacher time can be achieved in delivering the general education courses such that the combined cost of ITV-delivered general and vocational education courses is comparable to the cost of teacher delivery of general education courses alone. By utilizing ITV to provide both the new vocational education programs and the more standard general education courses simultaneously one can both minimize the requirements for new teachers to move to remote areas and free the time for existing teachers to broaden their skills.

2. Critical Numbers of Student Hours

Any given ITV delivery system must deliver a critical number of student hours of instruction per week to be economically viable. Assuming constant benefits per student hour, any ITV system is most cost effective when it delivers high enrollment courses. The average number of student hours delivered by a system is cut down by the introduction of low-enrollment specialty courses such as vocational education. The average number of student hours delivered is also cut down by repeat broadcasts of lessons for scheduling convenience. For a number of delivery systems studied, the cost savings associated with large enrollment programs exceeded the system costs by wide enough margins so that substantial proportions of low-enrollment vocational education courses were economically feasible.

3. Acceptance by Educators and Public

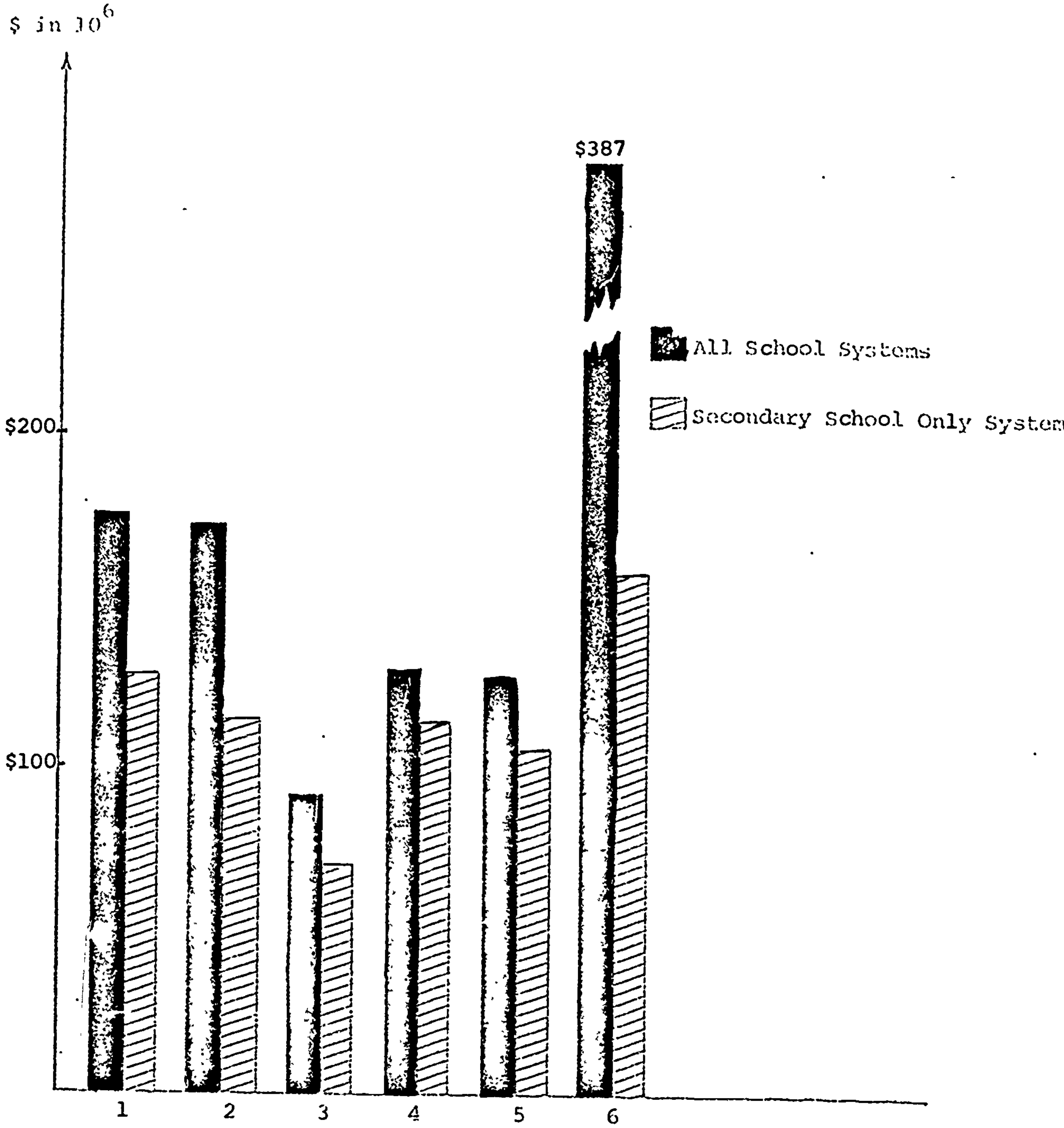
A critical factor in the success of a regional system is the acceptance by educators and the public (students and parents, in particular) from a broad geographic area. There has to date been little evidence to show that problems of coordinating curricula and schedules among several states and achieving broad financial support have been resolved. Demonstrations are therefore needed to indicate the level of acceptance and the nature of critical problems that are still poorly defined.

4. Multi-state Demonstration

A demonstration possibility deserving more detailed assessment is the provision of health occupations education simultaneously to at least two states. By including more than one state, problems of developing common curricula and schedules for different state systems are illuminated. The health occupation area has a strong demand in all of Appalachia and the use of ITV in the rural areas is particularly appealing because these areas do not strongly attract doctors, health manpower, or educators. Through the work of the Appalachian Regional Commission, substantial momentum for such a program has been developed.

5. Costs and Economic Feasibilities of Various Systems

Figure 1.1 illustrates approximately the cost estimates for various kinds of ITV delivery systems for the Appalachian states. The satellite direct reception is the least expensive system. The population density in Appalachia is



Key:
1) Cable with Microwave
2) Cable with Satellite
3) Satellite Direct Reception
4) ITFS with Microwave
5) ITFS with Satellite
6) Satellite Direct Reception with VTR Center at Each School

Figure 1.1 TOTAL ANNUAL SYSTEM COST (Administration, Reception and Distribution) great enough so that by selecting a high enough proportion of high enrollment courses, the four channel system can be made cost effective for all six hardware combinations. When a high enough proportion of vocational education courses are included, the combination of satellite and VTR in each school becomes infeasible.

E. Recommendations

We recommend additional studies on a range of topics important for understanding the role of telecommunications in the regional delivery of health, education and welfare services. These studies would be necessary to obtain information upon which a decision to attempt demonstrations could be based.

There are three categories of studies proposed:

- Programming. There is a need to better identify the specific services to be delivered and the design of the materials to assure effectiveness.
- Delivery hardware. Further information on the costs and capability of hardware configurations has to be obtained. Of particular importance is the need to assess the impact of limited spectrum and the competition between commercial and public demands for service.
- Area pilot projects with multiple services. Implementation problems include estimation of level of demand, development of alternative financing programs, study of state and local institutions.

In each of these areas we recommend a few important issues for study.

1. Programming

a. Program Core-Course Development

It is recommended that the status of available instructional materials be assessed for vocational education in health occupations. The costs of developing new materials should be determined in the course areas lacking quality material.

b. Project Demand Assessment

A systems analysis of demand for particular services is needed in the health occupations area of vocational education. There is a need for a realistic assessment of service cost over time and identification of potential sources of continued funding.

c. Other Education Areas

Systems studies of programming needs for the following areas of education are needed to determine how soon and at what cost services could be provided:

- Vocational education areas in addition to health occupations.
- General education courses in elementary and secondary schools.
- The open university concept of home study for the Appalachian states.
- The Graduate Equivalency Degree program concept.

d. Services Other Than Education

The health and welfare elements of social services, including programs integrated with private sector operations, should be studied to assess the role of telecommunications. A starting point for both health and welfare is an assessment of the impact of vocational education programs on health manpower and unemployment.

2. Delivery Hardware

a. Interconnection Technology

A deeper study of interconnection technology is needed for terrestrial and satellite systems. One important question for the satellite is orbital parking and spectrum flexibilities and capacities. Another issue is the possibility of shipping video tapes without relying on telecommunications. A third issue is the possibility of utilizing larger numbers of satellite channels. A fourth issue is the study of combining VTR systems and various mixes of distribution systems, several of which are already in place.

b. Two-way Systems

These were not examined in this study. What is recommended is not a system problem, but development of experiments to test audio links tied in with ITV. These have been used in limited cases and are closer to implementation than more sophisticated two-way video.

3. Area Pilot Projects

In this study we focused on a single service area -- vocational education. An important consideration in using telecommunications is the delivery of unrelated services over the same transmission system.

a. A Particular Area Study

It is recommended that one or more particular areas of the Appalachian region be studied for the delivery of a combination of health, education and welfare services.

b. Combination of Secondary School Programs With Voc-Tech Schools

To combine satellite delivery of combined vocational and general education courses has appeared very promising as a way to deliver lecture material. Vocational education requires both lecture and project experience. Vocational education project experience can probably be obtained for secondary school students by joint programs with the many existing vocational-technical institutes set up by the Appalachian Regional Commission. Such joint programs involving both regional agencies and also private companies should be studied carefully.

c. Evolutionary Development Studies

Setting up a satellite delivery system represents a massive centralized project. The ways by which such a system's evolution could be stimulated by building on existing institutions, programs, and interests should be explored and a set of initiating projects might be developed.

F. Summaries of Component Studies

1. Modes of Hardware Choices and Programming Choices

A comparative cost study of various telecommunication delivery systems was made and then evaluated against possible cost savings in the delivery of specific educational programs. Cost factors involved include hardware and administrative costs for constructing and operating the delivery system and programming costs and the dollar value of teacher time savings resulting from the use of ITV.

The purpose of the delivery system cost study was to examine various ITV delivery systems for the Appalachian states involving combinations of:

- Long-haul transmission via microwave or satellite.
- Local distribution via ITFS or cable, or directly from the satellite.
- Local replay and production facilities options.

This cost analysis was presented in Figure I.1 as it applies for a distribution system serving all public schools and for one serving only public secondary schools. From the cost component breakdown of the all school system in Table I-1, the following conclusions can be drawn:

- Direct transmission from the satellite to each school, as expected, is the least expensive basic system. However, VTR library-replay capabilities provided at each school in this satellite system cost several times the cost of the basic satellite system. Therefore, system scheduling flexibility with the satellite would have to be provided through multichannel rebroadcast using the regional system.
- VTR library and replay capabilities at each ITFS and cable distribution center provide flexibility at reasonable cost.

The administrative cost estimates assume two full-time administrative personnel located at each ITFS or cable center. This allows two administrators for about every 20 schools. The need for such administrative and coordination effort is great and the cost to provide it is a significant part of the overall cost.

The second part of the cost comparison was concerned with evaluating the value of possible teacher time savings for various educational programs utilizing telecommunications.

The benefits from each hour lesson delivered were assumed proportional to the total number of students served and were derived from operational programs.*

In Chapter V a number of specific education program examples were worked out with various mixes of vocational and general education courses. Both

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* The benefit per student-hour lesson derived as a rule of thumb was ten cents.

Table I-1

Annual System Costs in Millions of Dollars for Four Channel System Serving All Public Schools in Appalachian States

Distribution System	Interconnection		School Internal Distribution*	Local Distribution	Local Replay	Local Studio	Administration	Total
	Microwave	(Satellite)						
Cable	15.3	(6.8)	12.6	80.8	14.0	5.5	51.8	181 (172)[1]
ITFS	14.5	(6.7)	12.6	49.0	13.0	5.1	47.6	142 (134)[1]
Satellite	----	(17.4)	12.6	----	293.0	105.0	47.6	(78)[2]

* Reductions are based on utilizing the existing equipment in the schools estimated to have an annual cost of \$14.5 X 10^6.

[1] With local replay and studios

[2] Without local replay and studios

elementary and secondary school general education lessons were considered.

The results were these:

- The programming costs were not dominating in any case. High enrollment courses easily supported $60,000/hour programming and specialized vocational education courses, $6,000/hour.
- Because of the large numbers of courses and small enrollments in the specialized vocational education courses it is not economical to use ITV for them alone.*
- A mixture of vocational education and general education courses is feasible if rebroadcast is not extensively used.
- For the large-enrollment general education courses the benefits were so high that extensive rebroadcast to simplify scheduling was clearly feasible.

2. Assessment of Vocational Needs in Appalachia

There are three important characteristics of present vocational education in Appalachia.

- There is a need for more classes in vocational education for a dispersed student population in small enrollment courses.
- The quality of instruction has to be improved for the schools in general, including vocational programs. An important part of the improvement has to be increased in-service training for vocational teachers to raise their qualifications.
- There is a need to reapportion the numbers of students in each vocational area to match the projected manpower demands in Appalachia better.

a. The Need for More Enrollment Spaces

Projected enrollments show that secondary school vocational enrollments might double by 1975 over 1969 levels. Additional teachers and facilities will be needed, but it may not be possible to find teachers for remote rural schools. The implication of this is that telecommunications is the only alternative for providing instruction.

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* A four-channel system for the Appalachian states costs on the order of 90-180 million dollars per year or 2.5 - 5 million dollars per week and hence delivers 120 one-hour lessons per week at a delivery cost of 20,000 to 40,000 dollars per lesson. At a student benefit of 10 cents per lesson, any lesson to be economically feasible alone must be delivered to large enrollment audiences of 200,000 - 400,000 students.

b. Quality of Instruction

The use of telecommunications is attractive for providing quality instruction. By pooling production resources over a region, high quality instructional materials can be developed. This might improve the achievement levels of Appalachian students, which are below national norms. For example, the rate of failure for Appalachian state youth in the Selective Service Exam is as much as three times higher than the national average.

Also, quality in-service training programs can be provided via ITV for the teachers. This is important for a region where at least 13% of the teachers lack complete certification, and 32% of the trades and industrial education teachers have inadequate training in their subject area.

c. Reapportioning Enrollment

Projections of Appalachian region manpower requirements for 1975 show that the present enrollments in secondary vocational programs have disproportionate numbers of students in occupational areas with few job openings. Agricultural programs enroll about one fourth of the students in an area where numbers of jobs are actually declining.

Realignment of enrollments into different vocational areas requires more teachers in areas with previously low enrollments. The problem of getting qualified teachers into rural schools again suggests the use of telecommunications.

3. Case Assessments of Possible Demonstration Projects In Selected Appalachian States

The successful implementation of Federally-funded social service programs depends in large measure on the following factors.

a. Recognized Need

A recognized need by the potential service area community which indicates their priority assessment and willingness to commit resources.

b. Demonstrated Program Effectiveness

This is necessary for the acceptance of innovative and new-technology oriented programs by local government leaders faced with committing their community's resources to solving pressing needs.

c. Financial Credibility

Accurate definition of the local resources which must be committed to a project to insure effective results is essential in the commitment process by local government leaders. They must be assured that programs can continue to be supported and maintained through local initiative as necessary.

In order to identify first those programs capable of meeting the above criteria for success it is necessary to:

- Identify the existence of local public management/administrative structures committed to a social service area.
- Recognize the local social service objectives and programs to which these community representatives are receptive.
- Aggregate these local demands and determine where Federal stimulation and support is most necessary.

An exhaustive review of all local programs was not feasible in the time allowed for the project. As a consequence, we selected case studies for health-care delivery in the states of Alabama, Georgia and South Carolina with the purpose of identifying how this selection process might proceed according to the above criteria applied to telecommunications. The particular result was a need to demonstrate telecommunications' effectiveness and financial credibility locally in the following project areas:

- Increase vocational education counselling and student awareness in rural secondary schools of health occupation opportunities.
- Provide programs for extending the high quality health occupation instruction in urban areas to such instruction in more rural areas.
- Implement programs to allow consultation between rural health personnel and specialist in regional hospitals and health centers.

4. Assessment of Instructional Technology

Computer-assisted instruction (CAI), computer-managed instruction (CMI) and instructional television (ITV) were reviewed to determine their costs, their readiness for implementation and their use of telecommunications. On the basis of the review we concluded the following:

- CAI is not ready for large scale implementation. Continuing R&D activities are needed, so CAI was not considered in depth in this study.

- CMI is operational, relatively inexpensive and effective, but it is not a large user of telecommunications links. Therefore, it too, was not considered in this study.

- ITV is implementable and effective on the basis of systems operating for as long as 17 years. In all the cases reviewed, the ITV reduced the requirement of teacher lecture time and the cost savings thus realized covered the cost of the ITV system. It is also a major user of telecommunications. The decision was made, therefore, to focus entirely on ITV.

Chapter II

ASSESSMENT OF NEEDS

There are two components of the need in the Appalachian region for improved vocational opportunities:

- There is an insufficient number of vocational programs to meet projected manpower needs in certain vocational areas.
- Teacher qualifications on the average are below national norms.

In this section, we review briefly the present condition of vocational education in Appalachia in terms of these quantitative and qualitative needs.

A. Deficiencies in Number

In terms of quantity, not only are three two few programs in vocational education, but there is also a disproportionate enrollment in the fields of agriculture and home economics compared to the projected job markets. The latter point is shown in Table II-1 where the percentage enrollments in the secondary school of Appalachia in fiscal years (FY) 1966 and 1969 are matched against projected 1975 manpower demands. Over the three years from 1966 to 1969, there has been some realignment of enrollments toward meeting manpower demands. In 1966, some 62% of the enrollments were in vocational areas accounting for only 5% of the job market, agriculture and home economics, while in 1969 there was a drop in those enrollments to 56% of the total.

In terms of the number of programs available, the Appalachian Regional Commission has an objective to "provide the means for 50% of the 11th and 12th grade students in the region to enroll in job relevant vocational education courses" (Ref. 1). This compares to a 1969 value of 34.6%. If we assume that the goal of 50% is to be met in 1975, we can estimate the size of the vocational program for the region. On the basis of 1969 enrollments and an assumed growth due to population increases of 4% per year, the total secondary school vocational enrollment in 1975 is estimated to be 831,000 students. This compares with a 1969 total enrollment of 449,063 students, a difference of about 382,000.

Table II-1

PERCENT SECONDARY SCHOOL VOCATIONAL EDUCATION ENROLLMENTS BY VOCATIONAL CATEGORY WITH DISTRIBUTION OF PROJECTED JOB OPPORTUNITIES IN 1975 - ENROLLMENTS FOR FY-66 AND FY-69 - APPALACHIAN AND NON-APPALACHIAN U.S. - GRADES 9-12 (REF. 2)

Vocational Category	FY-66 Percent		FY-69 Percent		Calendar Year 1975 Percent Job Opportunities
	Non-Appalachian	Appalachian	Non-Appalachian	Appalachian	Appalachia
Agriculture	16.1	21.8	12.8	17.3	2.9
Distribution	3.4	2.5	4.8	3.2	16.9
Health Occupations	.3	.1	.6	.3	1.5
Home Economics	42.2	40.8	41.8	38.8	2.4
Office Occupations	26.4	24.3	38.0	26.5	17.2
Technical Education	.9	1.2	.7	1.7	3.3
Trades and Industry	10.6	9.3	11.3	12.3	44.0

To estimate the impact of this growth in secondary school vocational enrollments on the job market, we assume linear growth from 1969 to 1975 and the national average dropout rate of 21% from the 9th grade to graduation from high school. The number of graduates in 1975 would be 183,000 compared to 123,000 in 1969 (see Table II-2) or an increase of about 10,000 per year. Meanwhile, over the six years from 1969 to 1975, total manpower demands are about 1,200,000. This compares to a total graduated of 948,000. A major portion of the job market would thus be satisfied by these graduates, but only if there were a massive realignment in enrollments to match job demands. Without a major change from present trends, some 50% of the graduates would still be in agriculture and home economics, meaning that less than half the total job market could be satisfied by the secondary schools. Since the vast majority of students in home economics are not studying for "gainful employment", it is to be expected that a significant proportion will continue to enroll.

Since the secondary schools are but one of four major elements in vocational education, we should briefly consider the possible role of the other three. They are post-secondary schools, adult education programs and special need programs (such as for the handicapped). Table II-3 shows that secondary schools contained 65.4% of the total enrollment in vocational education in Appalachia in 1969. This figure has dropped 5.5% since 1966, so post-secondary adult and special needs programs are carrying more of the load. However, even at that rate of change, the secondary schools must supply at least half of the demand if it is to be met. The problem is complicated further because there is double counting due to many of the post-secondary enrollments coming directly from the secondary schools. For example, national statistics show that of 764,960 completing program requirements in secondary schools in FY 1971, 195,913 or 26% continued in full-time school (Ref. 3). Hence the combined contribution of the secondary and post-secondary schools is 74% from the former, 100% from the latter.

The point here is that we can expect enrollments to fall short of demand through 1975 even if ARC's total enrollment goal of 50% of secondary students is met.

We can question the assumption that the 50% goal can be reached for the secondary schools by 1975. In the three years following 1966, the increase in secondary enrollments for vocational education in Appalachia was 5.6% of total

Table II-2

DIFFERENCES BETWEEN GRADUATES AND DEMAND
SECONDARY VOCATIONAL EDUCATION (REFS. 2 & 4)

Vocational Category	Average Annual Job Openings	Graduates FY 1969 Number	Unmet Demand	Graduates Percent of Jobs
Agriculture	-20,000	12,700	Oversupply	Oversupply
Distribution	38,700	7,600	31,100	19.6
Health Occupations	7,300	900	6,400	12.3
Home Economics (Gainful)	500	31,000 (516)	Oversupply	Oversupply
Office Occupations	53,200	46,440	6,760	87.2
Technical Education	17,600	2,800	14,800	15.9
Trades and Industry	83,700	21,900	61,800	26.2
Total Unmet Need			120,860	

Table II-3

OVERALL ENROLLMENTS IN VOCATIONAL EDUCATION
IN APPALACHIA (FY 1969) (REF. 2)

	Magnitudes	Percent (%)
Secondary	449,063	65.4
Post Secondary	38,489	5.6
Adult	191,381	27.9
Special Needs	7,400	1.1
TOTAL	686,333	100.0

secondary enrollments, from 29.0% to 34.6% (Ref. 2). From 1968 to 1969, the increase was 2.9%. If this rate were to continue over six years, there would be 52.0% of the secondary students in vocational programs so the goal can be met with a continuation of current trends.

A final quantitative consideration of the provision of vocational programs is the dispersed demand in rural Appalachia. In Table II-4, the estimated secondary school enrollment of 831,000 vocational students is divided among the various vocational areas. Based on the enrollments in Appalachia in 1966-1969, it is estimated that in 1975 there will be 33.2% of total vocational enrollments in non-gainful home economics. The remaining 66.8% would be preparing for gainful employment in the other vocational areas. We assume those enrollments are distributed according to the projected manpower demands. The enrollments in rural counties are estimated as proportional to the population in those counties for which less than one third of the households are urban. The estimates obtained from 1970 census data published in References 1 and 32 show how dispersed the student population can be. Health occupations are the most serious in this regard, showing only 10.4 students per rural county. Considering there are more than 20 specialties in health occupations, it is possible to have only one or two students enrolled in a course. This is the case for the whole State of Ohio whose enrollments are given in Table II-5.

Quantitatively, therefore, we can see

- there is an unmet demand for vocational graduates in Appalachia;
- present enrollments are not distributed among vocational areas to properly meet those demands; and
- a high proportion of the Appalachian population lives in rural areas, resulting in a dispersed, low enrollment student population.

We now turn our attention to another need for improved vocational programs in Appalachia: higher quality.

B. Deficiencies in Quality

Appalachian schools fall short of national achievement levels both in their graduates and their teachers. For example, the low achievement of students is

Table II-4

MATCHING OF PROJECTED VOCATIONAL ENROLLMENT IN SECONDARY SCHOOLS AGAINST 1975 MANPOWER NEEDS

Vocational Area	Percent of Manpower Need	Secondary School Vocational Enrollment	Rural Counties* Total	Rural Counties* Average
Agriculture	2.9	16,100	5,270	20.1
Distribution	16.9	93,900	30,650	117.7
Health	1.5	8,320	2,730	10.4
Home Economics (Non-gainful)	-	276,000	90,400	346.0
Home Economics (Gainful)	2.4	13,330	4,360	16.7
Office and Business	17.2	95,500	31,300	119.8
Technical	3.3	18,300	6,000	23.0
Trades and Industry	44.0	244,000	79,900	306.0
TOTAL	100.0	831,000	271,700	104.1

* Defined as counties in which 1/3 or less of the households are classified as urban. The 261 counties so identified are 65.8% of the total number of counties and contain only 32.7% of the population (from Ref. 1).

Table II-5

SECONDARY SCHOOL HEALTH OCCUPATION ENROLLMENTS
OHIO, NOVEMBER 1971
(REF. 5)

Health Occupations	Male	Female
Dental Assistant	39	579
Dental Lab. Technology	0	4
Medical Lab. Technology	1	16
Medical Lab. Assisting	3	71
Nurse, Associate Degree	0	1
Nurse, Practical (Vocational)	19	100
Nurse's Aide	53	539
Psychiatric Aide	0	1
Other Nursing	1	0
Occupational Therapy	1	2
Physical Therapy	2	4
Radiologic Technology (X-Ray)	2	9
Optometrist Assistant	0	4
Environmental Health Assistant	2	4
Mental Health Technician	1	2
Electrocardiograph Technician	0	1
Medical Assistant	24	147
Community Health	0	1
Medical Emergency Technician	0	2
Food Service Supervisor	1	10
Mortuary Science	1	25
Other Health Occupations	4	14

shown by the fact that in 1967 in Appalachian Kentucky, only 62% of ninth grade students graduated from high school, compared to the national average of 73% (Ref. 1). Another example is that of the 13 states involved in Appalachia, eight have higher percentages of youth failing the Selective Service tests than the national average of 4.8% (see Table II-6). Ten of the thirteen states exceeded the national illiteracy rate of 2.4% of the population 14 years and older, with Alabama, Georgia, Mississippi and North Carolina at 4% or above, and South Carolina at 5.5% (Ref. 6). Other measures reinforce this picture but we will not add more data.

Part of the reason for low achievement on the part of the Appalachian schools is the lack of fully qualified personnel. A 1969 study by Arthur D. Little, Inc., showed that at least 13% of the teachers in Appalachia lack complete certification as opposed to a national average of 5% (Ref. 7). In addition, it can be assumed that some or all of the 8% in the sample who did not respond to the questions on certification also lacked credentials. In the particular area of trades and industrial education, which as shown earlier has the greatest manpower demand, 16.2% of the teachers had no courses in college or in-service training in the areas in which they now teach, and an additional 15.5% consider their training to be inadequate. Only 55% felt they had received sufficient training in college.

Of all the teachers surveyed, nearly 16% want in-service training programs brought in from outside their school system. Nearly 25% want more relevant programs. The potential here for using telecommunications is strong in view of the dispersed population in Appalachia and the high cost of bringing in qualified instructors.

Another aspect of the need for qualified teachers is the problem of supplying personnel in rural areas where the pupil-teacher ratio in specialty areas of vocational training have to be low. An example of the problem is the situation in health occupations programs in Alabama (Ref. 8). No programs are offered in 21 of the State's 67 counties, and all 21 are rural. In addition, only five of the 80 secondary schools offering health occupations programs have teachers trained in this area. Most of the students in health occupations never come in contact with a health occupations teacher in the schools. To deal with the problem, the schools arrange for the eleventh and twelfth grade students to work in the field for 20 hours a week and spend 5 hours a week in

Table II-6

PERFORMANCE ON SELECTIVE SERVICE TESTS
(REF. 6)

State	Percent of Draftees Failing Mental Test
United States	4.8
Alabama	8.8
Georgia	13.7
Kentucky	4.6
Maryland	3.1
Mississippi	17.1
New York	5.6
North Carolina	10.9
Ohio	2.0
Pennsylvania	2.7
South Carolina	17.9
Tennessee	4.8
Virginia	8.1
West Virginia	5.0

school under the supervision of a trades and industry coordinator. When the programs began field work some 30 years ago, the work load of practitioners was such that they could take time for instruction. Now, however, conditions have reached the state where there is insufficient time for instruction and the quality of the training has dropped (Ref. 9).

Even in the classroom, of the 40 students typically found in a class, each one may be training for a different vocational field. Since the coordinator cannot be skilled in all 40 fields, the major reliance is on workbooks for individual study, and guidebooks in each field to be used by the coordinator. There is a great need here to develop an instructional package that can bring higher quality instruction into the school and reduce heavy reliance on field work.

An additional problem exists in Alabama of providing adequate adult education in health occupations. There is a need for providing the same material used by secondary students to adults coming into the high schools for evening sessions (Ref. 9). In a recent survey, 4,259 adults were found on waiting lists for health occupation programs.

Finally, an area of concern in the secondary schools of Appalachia is the lack of adequate vocational counselling. The ADL study found that only 10% of the teachers surveyed felt they had sufficient in-service training for knowing the vocational opportunities open to their students. In Alabama, there are only 70 vocational guidance counsellors in the secondary schools and none are trained in a health occupation.

In summary, then, we have a situation of not enough qualified teachers, and lack of vocational counselling. In the next section, we consider implications for service programs to remedy the problem.

C. Implications for Service Programs

There are three important characteristics of the problem of providing expanded and higher quality vocational education opportunities in Appalachia:

- more student spaces have to be provided.
- many of the potential students are in dispersed rural populations.
- many Appalachian teachers today are not properly qualified for their work.

There are two ways of dealing with this problem of interest in this study:

- The conventional approach consists of hiring new teachers and providing instructors for in-service training at the schools or arranging for in-service training through nearby institutions of higher education.

- The alternative considered here is to combine an increase in the number of teachers with instructional technology. The technology would be used both for the vocational programs and in-service training of the teachers.

In this section, we briefly review the advantages and disadvantages of each approach.

1. Conventional Instruction

If achievable, the idea of providing teachers where needed is a straightforward and well-understood way of dealing with an educational need. In Appalachia, however, it is questionable that such an approach would succeed. The present low level of qualified teachers already discussed is an indicator that it would be difficult to attract highly qualified teachers. It would be very difficult and expensive to find highly qualified teachers to teach in remote rural areas, particularly teachers in specialty areas of vocational education. When we consider that the projected enrollments of 831,000 represent a 54% increase over FY 1969 enrollments, it seems highly unlikely that a corresponding increase of highly qualified teachers would be realized.

In-service training would similarly be a very expensive proposition if instructors were sent to each of the schools as desired by the Applachian teachers (according to the survey of Ref. 7). The alternative there is to provide for training at the closest institution of higher education.

From the standpoint of both cost and feasibility, an alternative is needed.

2. Instructional Technology

The alternative of interest here, namely a combination of an increase in the number of teachers and implementation of instructional technology, is potentially well-suited to the problems of Appalachia. Table II-7 contains a list of the benefits of instructional technology of all types, including those under study here, CAI, CMI and ITV. The first item on the list, increased productivity, means that a given number of teachers with technological assistance can instruct a larger number of students than the same number of teachers acting

Table II-7

EDUCATIONAL USE OF INSTRUCTIONAL TECHNOLOGY
STATE OF THE ART (REF. 10)

Potential Advantages

- Increased productivity
  - Speed up rate of learning
  - Routine information transmission taken away from teacher
- Individualized instruction
  - Flexible scheduling of content
  - Administrative
- More scientific base for instruction
  - Reinforcement and reward
  - Research is readily conducted
- More powerful instruction
  - Different perceptions can be presented (slow motion, magnification, etc.)
  - Non-verbal cognitive processes can be developed
- More immediate learning
  - Shorter time constant than printed material
  - Simulation and participation programs can involve the learner
- Equal access (teacher's values are not imposed as strongly, an important issue in dealing with disadvantaged children)

Problems in Implementation

- Lack of practical understanding about the process of human learning makes it difficult to select best mix of technology and traditional methods.
- Lack of money limits investment in capital equipment.
- Institutional pattern of education (grades, courses, credits, etc.) does not permit optional use of technology.
- Specific reasons for the lack of widespread implementation:
  - Indifference or antipathy toward using technology in education on the part of teachers and administrators
  - Poor programs (a majority of TV, films, CAI, and programmed texts are of poor quality)
  - Inadequate equipment
    - poor design
    - incompatibility
    - obsolescence
  - Inaccessibility
    - difficult for school TV producers to find information
    - copyright problems
    - teacher workload makes it difficult to plan and use technology
  - Teachers not trained to understand role of technology
  - Media specialists are usually excluded from training and planning.

alone. This would mean that technology can help reduce the number of additional teachers needed in vocational education. The use of telecommunications brings the added advantage of being able to reach dispersed target populations at relatively low cost.

The remaining items on the list concern the quality of instruction. Evaluations of the effectiveness of CAI, CMI and ITV have shown that when properly used, these technologies are at least as good as and often better than conventional instruction. The teacher's role is often enhanced when technology is introduced since there is less time required for the delivery of routine lectures and more time for individual attention to students. And, the opportunity exists with the use of technology to package the lectures and ideas of leading educators and researchers in each course area and transmit them to a widely dispersed audience. This would be particularly valuable for the rural students of Appalachia.

Unfortunately, the benefits of instructional technology are not often realized in practice. Table II-7 also contains a list of the problems of implementation common to all the technologies. Foremost among them are costs and teacher attitudes.

At a time when school finances are being stretched over a growing student population, there is little opportunity to introduce an expensive and not fully proven technology. The only way in which this could be accomplished in many school districts is if the technology reduces overall costs. Since the problem we are considering in Appalachia is one of expansion, cost savings must be a criterion in our evaluation of potential uses for technology.

Teacher attitudes against the use of technology can be traced to a number of causes: inadequate understanding of how technology can play an effective role in instruction, no opportunity to participate in the planning, and poor quality of the content. Any effort that has been successful in the implementation of technology, such as ITV in Anaheim, California, and Hagerstown, Maryland, has involved the teachers in planning for its use. With adequate financing and good planning, it appears that the problem of teacher attitudes can be resolved.

At this point, it is important to distinguish the cost, the effectiveness and the implementation problems of CAI, CMI and ITV in order to better understand our options in the use of technology. That is the subject of the next section.

Chapter III

FACTORS IN CHOOSING TECHNOLOGY

We are concerned in this section with stating the criteria important in choosing technology, examining the role of each technology (CAI, CMI, and ITV) in the instructional process, and then assessing the present status of each in turn. As a result of this assessment we focus the remainder of the study primarily on ITV as being implementable on a wide scale.

A. Considerations for Selection

In examining different technologies for possible implementation we consider the following characteristics:

- Costs. For most cases there is a limit in cost beyond which a system cannot be considered no matter how effective. If, however, costs are close to those of conventional instruction, then a more detailed assessment of the system is needed.

- Status for implementation. We are concerned in this study with identifying technology which can be implemented for operational use in the immediate future. Systems still in the research and development stage are not considered.

- Use of telecommunications. This study is concerned with the development of telecommunications and its effect on educational services. Therefore, systems without major transmission requirements are not expressly considered.

Each of these consideration categories will be considered in the review of CAI, CMI and ITV. First, however, we will discuss the role of each of these three technologies in the instructional process.

B. The Instructional Role of Technology

In order to properly select a technology for implementation, we must understand how it can be used effectively for instruction. With this as our purpose, we divide instruction into four functions:

- Lecture - transmission of information from an individual to a group.

- Tutoring - individualized instruction with interaction between the student and the instructor.

- Management - testing, curriculum management, and guidance and counseling.

- Library - provision of resource materials.

Each of the technological systems we are concerned with fits into a different part of the instructional process in its primary operation:

- CAI is primarily a tutoring process, although in some systems there are elements of lecture, management and library processes. Drill and practice, problem solving, gaming, simulation and testing are all feasible for CAI systems.

- CMI is a management tool, and, in different systems, may perform test development for teachers, test scoring, identification of remedial or follow-on materials for each student and development of study plan for each student. Vocational guidance and counseling is an important function that is included in the CMI label even though it is not strictly an instructional process.

- ITV is primarily a lecture tool. When programs are stored in video tape form, a library function is served.

We can expect that for most situations the optimal instructional package would consist of a combination of teacher and one or more of the technologies. As an aid in identifying possible combinations Table III-1 shows the primary instructional functions of the teacher and each technology.

It is difficult to make a general statement about the relative role of lecture and tutoring by an individual teacher, so the boxes are not separated in the table. What we can do is show the average division of an Appalachian teacher's work week among classroom, course management and other staff duties (such as lunchroom monitor). Table III-2 shows the hours spent in each category for average and also extreme cases. This information is of use because as an example it shows that 6 out of 37 hours or 14% of the teachers time is spent in preparation for classroom teaching. CMI would appear to play a significant role if it can effectively reduce the teacher's time spent on routine bookkeeping and leave more time for lesson preparation and involvement with individual students.

With some additional information on conventional classroom procedures it would be possible to identify the proportion of teacher time involved in lecturing and tutoring. Then the potential role of CAI and ITV could be more clearly defined. As so often happens, of course, a review of present practices might lead to a complete reworking of instructional procedures. An example of how

Table III-1

ROLE OF TECHNOLOGY IN INSTRUCTION

	CAI	CMI	ITV	Teacher
Lecture			X	X
Tutoring	X			
Management		X		X
Library			(video tape)	

Table III-2

HOURS SPENT IN TEACHING AND OTHER DUTIES (REF. 7)

Duties	Median hours spent each week	10% of teachers report spending fewer hours than	10% of teachers report spending more hours than
Classroom teaching	26	7	33
Preparing in school for classroom teaching	6	2	10
Other duties, such as cafeteria, study hall, counseling, library, administrative, or supervisory duties	5	0	10

this can occur is the open school concept in which individualized development is stressed and team teaching is utilized.

For the purpose of this study, only the primary relationships of CAI with tutoring, CMI with management and ITV with lecture are considered. With those relationships established we now consider each technology in terms of its cost, quality, usefulness in areas of scarce resources and organizational constraints.

C. Computer Assisted Instruction

Three large CAI systems designed to utilize several hundred or more terminals over a broad geographical area were reviewed for cost data and status of implementation. The three are PLATO IV (University of Illinois), TICCIT (Mitre Corp.) and the IMSSS system (Stanford University). The results show that large system CAI is still well above conventional classroom instruction in cost per student contact hour (more than $1.00 for CAI vs. $.42 for conventional). Table III-3 summarizes the status and costs of these systems. Hardware costs are given in Tables III-4, 5, and 6. Another major development effort funded by the U.S. Army is intended to develop a system for military training programs. At the present time, it is in a development stage and is not yet implementable (Ref. 11).

The first opportunities for the cost-effective use of large CAI systems are:

- compensatory education,
- dispersed populations in high-cost education programs, and
- very low enrollment courses.

As discussed earlier, vocational education in Appalachia involves some very low enrollment courses so at some point in time large CAI systems might be considered for use. For the present however, there are unresolved problems in fully incorporating them into school programs. Continued research and development is needed before they can be implemented on a large scale (Refs. 12 and 13).

At a time when significant changes can be expected in both the costs and the role of CAI through present R&D efforts, it is premature to consider near-term implementation. Since this study is concerned with near-term implementation , we do not include large CAI systems.

Costs competitive with conventional instruction are achieved with the Computer Curriculum Corporations small 8 - terminal system. However, these systems are designed for single classroom use and do not use communications. Small CAI systems are therefore not studied further in this project.

Table III-3

CAI COSTS*

Large systems (several hundred or more terminals over a broad geographic area)

- PLATO IV, now under development, is designed to handle 4000 student terminals and eventually permit costs as low as $.50 per student contact hour. A 500 terminal system would now cost $1.25 to $1.50 per hour, with the major element being the advanced terminal system production costs. Hardware costs for the 500 terminal system total $11,000 per terminal, with each terminal costing $5000 and the central processing unit and its equipment costing $3,000,000 (see Table III-4).

- TICCIT is being designed to have operating costs of less than one dollar per hour in the long run. Courseware costs are expected to run about $0.15 per hour, assuming 20 schools, 1000 hours utilization per year, 100 terminals and 5 years giving 10 million student contact hours. Per terminal hardware costs are presently $3600 (see Table III-5) but this is expected to drop to $2000 in production lots (Ref. 12).

- A system for 1300 terminals based on the system used at the IMSSS at Stanford has hardware costs of $2330 per terminal excluding communications costs (see Table III-6).

Small systems (5 - 20 terminals in a single location)

- Only one system was considered. The Computer Curriculum Corporation is marketing an 8 - terminal system which, depending on utilization and amortization assumptions, can cost from $.38 to $1.72 an hour. The courseware is marketed also for use on any major computer manufacturer's equipment. With the small systems there is no need for telecommunications (Ref. 14).

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* These systems are individually different and it should not be assume that they have similar operational properties. Our purpose is to show the generally high cost levels associated with CAI systems which provide intensive student interaction.

Table III-4

PLATO IV HARDWARE COSTS (REF. 15)

Assuming a 500 terminal system:

CPU and related hardware:	$3,000,000
Terminals ($5000 each)	2,500,000
Total	$5,500,000
Total cost per terminal:	$ 11,000

Table III-5

EQUIPMENT COSTS OF CAI SYSTEM COMPONENTS FOR 1,300 TERMINALS
(Excluding Communications)
(REF. 16)

Component	Description	Cost
Core Memory System	256K words on-line plus two working spare 32K boxes. Including individual 6-port interfaces and port connectors	$ 330,000
Central Processor	Program compatible with the PDP-10 and including a pager.	300,000
Drum	4.5 million word storage on three drums.	235,000
Disc	Two separate systems each with about 50 million words of storage.	240,000
I/O Multiplexer	Includes a multiplex computer and a special purpose multiplexer.	225,000
Data Communication	Local test and patch facilities and test equipment.	100,000
Terminals	1,450*student terminals @ $900	1,305,000
	10 system terminals @ $4,000	40,000
Miscellaneous	Magnetic tape drives,	100,000
	Line printers,	50,000
	Disc packs, magnetic tapes, terminal spare parts, storage facilities, etc.	100,000
TOTAL		$3,025,000
	Total cost per active terminal	$ 2,327

* 150 terminals to be used as substitutes when repairs are needed on any of the 1,300.

Table III-6

TICCIT HARDWARE COSTS TODAY (REF. 12)

Main Processor	26,000
Terminal Processor	21,000
Card Reader	4,000
Line Printer	11,000
Magnetic Tape Unit	9,000
Moving Head Disc Control (2)	17,000
Moving Head Disc Drives (3)	36,000
Fixed Head Disc Control (2)	7,000
Fixed Head Disc Drives (1)	5,000
CRT Terminal	3,000
Computer-to-Computer Link	3,000
Character Generator	7,000
Vector Generator	11,000
Keyboard Interface	5,000
Audio Response Units (20)	60,000
Audio Response Control & Switching	10,000
TV Sets (Color) (128)	38,400
Keyboards (128)	19,200
Luminance Refresh (128)	76,800
Chroma Refresh Units (128)	11,000
Signal Processing Amplifiers (128)	32,000
Video Tape Players (20)	16,000
Refresh Control Electronics	10,000
TV Modifications	25,600
TOTAL	$464,000
Total per terminal	$ 3,625

D. Computer Managed Instruction

Three specific uses of computers were examined under the heading of CMI:

- Guidance and counseling
- Testing
- Curriculum management.

Representative systems were identified for each use. Table III-7 contains a summary of each. Others are identified and discussed in Refs. 17 and 18. The results obtained were that CMI is feasible, inexpensive for schools already using computers, and effective. Because CMI is a low user of telecommunications it was decided not to continue study of its potential. Hardware and software are available, telephone lines provide adequate communication links and if the demand exists these systems will be bought and used.

E. Instructional Television

ITV has been in operation for 17 years. It has been found to be self-supporting and effective. In this section we review a few selected cases of the successful utilization of ITV and also consider reasons for its failure in other places.

1. Successful Utilization Cases

We have examined the followir operarions in ITV:

- Washington County, (Hagerstown) Maryland. This system has been in operation for 17 years and presently broadcasts 41 courses weekly to elementary and secondary schools with a total enrollment of 23,000. Vocational education courses are just now being prepared for taping (Ref. 19).
- Anaheim, California, has had an ITV system in operation for 14 years. The school district is providing 144 separate programs per week. For students in kindergarten through 8th grade, 12 to 20% of their class time is spent with ITV (Ref. 20).
- Santa Ana, California, has been operating an ITV system for 10 years. It provides broadcasts for over 31,000 students at every grade level in elementary and secondary schools. In 1972 there are presently 133 telecasts per week to the elementary schools alone. Consideration is being given to televising vocational education courses (Ref. 21).

Table III-7 CMI ASSESSMENT - REPRESENTATIVE SYSTEMS

PROGRAM	LOCATION	FUNCTION	COST	UTILIZATION	EVALUATION
CVIS (Computerized Vocational Information System)	Willowbrook High School, Villa Park, Illinois	Provides Vocational exploration, four year colleges and technical school information	For a school of 3000 to 3500 students, $19,000 per year. Includes telephone line rental from school to computer	11,000 students in 1970-71 from five high schools. In operation every day from November 1968, average use per student is 4 to 6 sessions of 40 minutes each.	Shown to be effective (Ref. 22).
CTSS (Classroom Teacher Support System)	Los Angeles City Unified School District	Construct and score tests, maintain teacher and student response records	$50,000 per year for consultants. Negligible computer cost. Mail used for input and output.	One course - U.S. history. Will be adding U.S. Government and math over next two years	No formal evaluation available. Response of teachers favorable. Some teachers use questions for individual student study programs. (Ref. 23).
AIMS (Automated Instruction Management System)	New York Institute of Technology, Old Westbury, New York	Scores tests, directs students to material, maintains records on individual and performance. mode and haring (for ate feedback)	Batch mode $.40 - $.60 per student per course per semester. Time sharing: $1.50-$2.00	Variations of basic system in use for NYIT course, still in development stage, but has been used on about 750 students.	Used during curriculum changes, so no formal evaluation is possible. Positive reaction from students and faculty (Ref. 24).

- Dade County, Florida, has had its ITV system operating for eight years. The use of ITV has flucuated, especially during the period in which the Dade County schools had an influx of new students due to Cuban refugees arriving in the early 1960's. Quality became an issue when ITV was rapidly expanded to cover the influx as a substitute for nonexistent teachers. Readjustments were made and the system is continuing its operation (Ref. 25).

- The State of Utah has begun, in October 1972, to broadcast the first of a series of vocational education courses over the State ETV* network. There are 60 programs of 30-40 minutes duration, constituting nearly 50% of the course time (Ref. 26).

- An example of ITV use in technical areas is to be found in the RCA company program for instruction. Every RCA plant has some local university connection. TV programs are shown typically in 12-2 hour sessions, and an associate instructor is with the class to handle discussions and monitor progress. Study guides are prepared for the courses and include still frames from the televised material (Ref. 27).

Other ITV systems exist around the nation. A general survey was not thought to be needed since the cases reviewed showed that ITV can be successfully implemented.

2. The Effectiveness of ITV

We do not go into great detail on the effectiveness of ITV. Comprehensive assessments of ITV by Chu and Schramm (Ref. 28) Reid and McLennan (Ref. 29), and Jamison, Suppes and Wells (Ref. 30) all agree on one main point: ITV, when properly used, is as good as or better than conventional instruction. The interested reader can find substantial detail in the cited material. We wish only to abstract a few important considerations from the results.

One is that continuing evaluation is a necessity to maintain quality. An example already mentioned is that the Dade County Schools relied so much on ITV to make up for lack of facilities and teachers that quality suffered. The shortage of funds which caused a teacher shortage also led to deterioration of equipment and poor programming (Ref. 25). After a restructuring of the operation the system has improved and apparently is again producing effective programming (Ref. 31).

Another important point is that ITV programs have to be well integrated into lessons. In the spring of 1971, three groups of students in Santa Ana were tested to determine their increase in knowledge:

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* Educational television.

- Group A, with classroom instruction only, showed a 52% increase in knowledge. 15% of the students showed no increase.
- Group B, with ITV instruction only, showed a 45% increase in knowledge. 15% of the students showed no increase.
- Group C, with both ITV and classroom instruction showed a 67% increase i.. knowledge. Only 10% showed no increase.

In line with these results, in the Santa Ana schools the television is considered only one third of an instructional lesson. Preparation and follow-up each represent an additional one-third (Ref. 25).

In order to have proper integration in the classroom, it is important that teachers be integrated into the planning activities for programs. In Hagerstown, Maryland, for example, for each course there is a committee from each school including three teachers and the principal who meet with the TV teacher for six 1/2 day sessions to plan content and scheduling of the next year's programs. This may not be enough involvment of the teachers for there are presently some problems with teacher acceptance. However much is needed, the Hagerstown system has managed to survive at this level so it might be considered a minimum.

Finally, it is often necessary that resources be pooled among school districts to provide adequate financing for programming. Low quality programs are inexpensive but self-defeating. High quality programs are expensive. A necessary condition for the survival and effectiveness of ITV is that enough money be made avaiable. Regional organizations, by guaranteeing a market for locally produced programs can reduce their selling price. For example, the Regional Educational Television Advisory Council (RETAC) in Los Angeles has 57 member districts. The Santa Ana schools could purchase social science series from RETAC for $12,565 as against $19,000 when purchased from the Anaheim schools. There is an additional benfit of having a wider choice of materials made available through such regional organizations.

3. Cost Assessment

The general experience of school districts using ITV is that there are significant savings to be realized through reduced expenditures on teacher salaries. The procedure followed is to group smaller classes together in a single room for telelessons. In Anaheim and Santa Ana this is done on a half-day basis. For half the day, students from one grade meet in a TV "resource room" with two teachers and an aide for each 100 students. Another grade in classes of about 25 each meet in home rooms with one teacher each. For the second half of the day the classes change places. The net result is that for each 100 students there is a staff of 4 teachers for half the day and two teachers and an aide for the other half as opposed to four teachers all day.

Hagerstown, Maryland, operates somewhat differently, combining three classes for a standard school period to use ITV with one teacher in charge. This saves two teacher periods per ITV period. In addition, Hagerstown saves on the number of specialty teachers by televising weekly art, music and conversational French lessons.

The savings realized in this way pay the cost of the ITV system. In addition, Anaheim, Santa Ana and Dade County realized a reduced need for classrooms. The problem with this type of saving is that it is tempting to overload the system to keep educational expenditures down as we have seen in the case of Dade County. Given precautions to maintain quality, however, it appears that ITV can be self-supporting.

F. Conclusions

On the basis of the information obtained on CAI, CMI and ITV the following conclusions were reached:

- CAI is not developed to the point where it can be implemented for large-scale usage. Costs are rapidly declining and greater understanding of its use is being developed. CAI should remain in the R&D stage in the near future.

- CMI is operational and relatively inexpensive. Schools desiring to use it can acquire programs and hardware. Since the use of telecommunications is limited to telephone line rental, it should not be studied in depth on this project.

- ITV is implementable, effective and generally self-supporting. It has not been implemented over such a broad region as is being considered in this study. The remainder of this capabilities study deals with a detailed assessment of the costs of regional ITV and an assessment of organizational and implementation problems.

Chapter IV

ALTERNATIVE ITV DELIVERY SYSTEMS

A. Introduction

In this section we discuss alternative ITV distribution systems, including ITFS, satellite, and cable television. We describe the configurations selected for analysis, the major characteristics of each system, and factors important for implementation over a region in terms of local production of programs and scheduling.

B. System Configurations

The system configurations studied in this project are as follows:

- Local ITFS distribution systems linked by a regional microwave network.
- Local ITFS distribution systems linked by satellite.
- Satellite broadcast direct to each school.
- Local cable distribution systems linked by a regional microwave network.
- Local cable distribution systems linked by satellite.

In addition, local replay and production capabilities are included. The only major system not included in the analysis is UHF broadcasting. In the following discussion it is shown to have limited educational use.

The system design configurations are indicated in Table IV-1. All the ITFS and CCTV*systems assume replay and studio facilities at the local transmission points. The direct satellite reception costs on the other hand are estimated both for no local replay or studio facilities and for local replay at each school. Each of these configurations has organizational implications which can be weighed against costs. In practice, the ITFS and CCTV regional systems can be developed on a local system-by-system basis with interconnection provided when the system requires it. These regional systems also provide the local control desired by school systems. The direct satellite system with no replay capability by comparison lacks much in the way of local control over scheduling

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* CCTV: Closed-circuit television, refer to page 45.

Table IV-1

REGIONAL SYSTEM DESIGN CONFIGURATIONS
FOR COST ANALYSIS

Local System	Interconnection Microwave	Satellite	Replay	Local Prog.
ITFS	X		X	X
ITFS		X	X	X
CCTV	X		X	X
CCTV		X	X	X
Satellite		X		
Satellite		X	X	

and organization. The direct satellite with replay capability is a more workable system in that it provides for local rescheduling and replay from local tape libraries. It is a natural extension from the satellite only scheme moving towards greater organizational flexibility.

C. Discussion of System Components

1. Instructional Television Fixed Service (ITFS)

ITFS is an over-the-air broadcast service in the 2500-2690 MHz band. This frequency range is out of the standard VHF-UHF region and, therefore, special converters are required to receive it. As a result, it is not available to the general TV viewing public. Special frequencies have been authorized by the FCC for audio or data response transmission thereby providing two way audio capacity. FCC regulations on transmission power limit effective range to about 10-20 miles. This emphasis on limited power is done to extend the re-use availability of this part of the frequency spectrum containing about 30 video broadcast bands to other users. With no more than four channels to each user, this provides for a limit of about seven stations operating in the immediate vicinity of one another. However, the limited power and range allows some channel reassignment to other stations in the area. Since transmitting facilities are local, they are accessible to the community using the ITFS facility and, therefore, can be made fairly responsive to local origination needs and scheduling.

The use of ITFS to distribute over a large geographic region is specifically prohibited by the FCC in Paragraph 26 of the Report and Order on Docket No. 14744 which bans the use of ITFS "to distribute material over an entire state or a large portion thereof."

2. Broadcast UHF-TV

UHF is not included in the alternative ITV systems because of the following reasons. Like ITFS, UHF utilizes limited resources of the over-the-air broadcast spectrum. Unlike ITFS, however, it can be picked up directly by people on their home TV sets. Therefore, everyone who owns a TV set has paid for the capability to pick up these stations. As a result, the FCC in the past has tended to discourage the express use of these channels for ITV or special purpose applications not intended for the entire public. Therefore, multichannel access would be particularly hard to obtain for educational purposes.

For example, in 1968 the Georgia State Board of Education petitioned the FCC for 30 UHF channels and was turned down. The FCC also refused to allow the airborne television project in Indiana to continue using the UHF channels assigned to it and reassigned six ITFS channels to be used on a local basis. The FCC has, therefore, for the present, apparently precluded the ability to use UHF for multichannel instructional television over a wide area.

3. Cable Television

For practical purposes cable is an unlimited transmission resource since it does not utilize the scarce over-the-air frequency spectrum. It may be utilized in either of two forms: community access television (CATV) or closed circuit television (CCTV).

CATV is regulated by the FCC and for this purpose is defined in the Federal Register Vol. 37, No. 30 paragraph 76.5 as,

> "Cable television system (or CATV system). Any facility that, in whole or part, receives directly, or indirectly over the air, and amplifies or otherwise modifies the signals transmitting programs broadcast by one or more television or radio stations and distributes such signals by wire or cable to subscribing members of the public who pay for such service, but such term shall not include (1) any such facility that serves fewer than 50 subscribers, or (2) any such facility that serves only the residents of one or more apartment dwellings under common ownership, control, or management, and commercial establishments located on the premises of such an apartment house."

CCTV, on the other hand, refers to systems which include origination, distribution and reception and, therefore, do not involve retransmission of over-the-air broadcast. In this sense, they are not subject to FCC regulations.

Important FCC regulations in CATV provide for a free educational channel for a 5 year period in the top 100 TV markets. Eleven of these are in Appalachia. In practice, however, there may be competing uses of this educational channel making it unattractive for the major commitment of educational users as required for ITV applications.

The cost analysis in the system cost appendix for CATV and CCTV concludes that for point-to-point distribution among schools it also appears cheaper from a social viewpoint to use CCTV. This result is based on the underutilization of resources available in using a system which runs to all community homes for specialized regular distribution. However, in the dynamics of initial CATV development, the cable operators may be willing to subsidize educational users of a cable system until system capacities approach limits. On a temporary basis, such point-to-point use for educational distribution of ITV in CATV systems may be advantageous, but it would appear not to be a good long term policy. Therefore, the systems proposed for evaluating ITV usage of cable television will consider the reduced costs associated with using CCTV for ITV as reflecting the long term picture. CCTV systems, like ITFS systems, tend to be localized and hence provide access to the origination point by the local area being served.

4. Satellite

Multichannel instructional television can be provided over a wide area by satellite. The costs for direct transmission to schools is independent of local terrain characteristics and geographical separation of receiving points. However, local access to program origination and local scheduling problems can cause organizational difficulties in its application over a region. These implications will be discussed further in the chapter on cost which follows.

5. Regional Interconnections

The systems considered are terrestrial microwave and satellite systems. The primary advantage of terrestrial microwave systems is that they may be constructed in stages as required. The primary advantage of satellite interconnection systems is lower cost as will be discussed further in the next chapter. The main difference between the satellite interconnection system and direct satellite transmission system described earlier is that the interconnection system broadcasts to a ground facility which retransmits to individual schools rather than direct transmission from satellite to school.

6. Auxiliary Facilities

Here we are concerned with provision for local replay capabilities and local production. The local replay facility incorporates a video tape library along with video tape recorders (VTR) and an operator for recording and replaying transmissions. The local production facility is described in Appendix A.

D. Design Considerations and Organizational Flexibility

Two aspects of system design as it relates to organizational flexibility are discussed. The first relates to the desire for local production facilities and hence access to local program origination. The second concerns the need for local replay capabilities to accomodate scheduling. Present practices and desires of concerned parties are reviewed and implications for system design are inferred.

1. Local Programming

In regard to special programming services for Appalachia, Washington University conducted a survey of Appalachian State ETV stations and community owned stations to determine preferences for local versus centralized production and their preference for a common-interstate feed (Ref. 32). The results are presented in Table IV-2 and IV-3. These tables seem indicate a strong interest in the local production of special programming.

Another idea of local programming needs was obtained by analyzing a survey of ITFS stations operational as of January 1971 (Ref. 33) and summarized in Table IV-4. An analysis of this data gave the results in Table IV-4. The local origination thus seems to be on the order of 35%. The column for total average hours per channel seems to give low results and there is some question as to whether the numbers collected consistently represent total channel hours per week as confirmed in spot checks with ITFS systems queried or total system operating hours. The results, however, do indicate a substantial use of local programming. All 65 ITFS facilities had local programming facilities, although one used 16 mm film rather than video.

2. Replay Capability

In regard to the need for replay capability in order to meet local scheduling needs, we would expect additional difficulties when applying instructional television to high schools. This results from the class periods structure inherent in school schedules with different schedules for different subjects. A regional facility such as a satellite distribution system could provide for some replay during a normal broadcast day. However, it is not expected that this would find acceptance across an entire multistate region. Instead some local provision of facilities for delaying broadcast to an appropriate time would be necessary.

In the next chapter, we will consider these various options for allowing operational flexibility and determine their associated costs.

Table IV-2

STATE ETV STATION SURVEY BY WASHINGTON UNIVERSITY (REF. 32)

State	Local vs. Centralized Production Preference	Preference for a Common-Interstate Feed	Reaction to SECA[1] Playing This Role (Common Feed)
Alabama	Locally Produced	Negative	Negative
Georgia	Either if good quality	Negative	Negative
Kentucky	Either. Program quality matters	Yes	Yes
Maryland	. . . .	. . . .	. . . .
Mississippi	Either. Quality matters	Yes	Yes
New York	. . . .	Negative	. . . .
North Carolina	A mix	Negative	Maybe
Ohio	A mix	Yes	Yes
Pennsylvania	A mix	Yes	Not unless provision is made to include areas served by EETN[3] & CEN[2]
South Carolina	A mix	Yes	Absolutely!
Tennessee	A mix	Yes, but could also use trucking of tapes.	Yes, if all stations interconnected with SECA[1]
Virginia	A mix	Not on a regular basis. Occasional	Not in its present configuration
West Virginia	Prefer local production	Negative. Such a move will accentuate Appalachian tendencies for isolation.	No

[1] Southern Educational Communications Association

[2] Central Educational Network

[3] Eastern Educational Television Network

Table IV-3

COMMUNITY ETV STATION SURVEY (REF. 32)

State and Station	Preference for Local versus Centralized Production	Attitude Towards a Common Interstate Feed for the Region
New York WSKG-TV; Binghamton	Local	Only if the feed is general rather than specific
Ohio WOUB-TV; Athens	Local and/or centrally produced programs with funding to add elements to tailor to specific requirements	Definite interest
Ohio WCET; Cincinnati	Local	Interested
Pennsylvania WLVT-TV; Bethlehem	Local	Interested
Pennsylvania WPSX-TV; Clearfield	Preferably Local	Most of the material can be delivered by tape
Pennsylvania WQED; Pittsburgh	Suggested that one contact CPB[1] regarding its contemplated ALPS project	Not studied the matter
Virginia WBRA-TV; Roanoke	Local and centralized mix	Not necessary. Occasional interconnect would be desirable.
West Virginia WWVU-TV; Morgantown	Prefer local; Would accept non-local.	Possible

1 Corporation for Public Broadcasting

Table IV-4

PERCENT LOCAL PROGRAMMING

Channels	Number of Systems	Average Percent Local Production	Total Average Hrs/Channel
1	13	43%	27
2	19	33	17
3	7	49	17
4	16	30	17

Chapter V

COST ANALYSIS OF EDUCATIONAL PROGRAMS USING ITV

A. Introduction

In this chapter, various educational programs in ITV are structured to achieve cost savings possible through the implementation of telecommunications. Alternative ITV delivery system configurations are developed and a cost analysis made of each. Finally, each delivery system cost is compared against possible savings to determine those combinations of educational programs and ITV delivery systems which would not require a larger total education budget.

Alternative educational programming packages are considered which have different combinations of target courses and telelessons. Four combinations are examined, all assuming a four-channel ITV system:

- Scheme I. 120 hours of programming per week are devoted to 120 low enrollment vocational education courses. There are only single telecasts for each course.

- Scheme II. 54 hours per week are devoted to three telecasts of 18 large enrollment general education courses in the secondary schools. The remaining 66 available hours are devoted to 66 low enrollment vocational education courses with no replay.

- Scheme III. 30 courses in grades 1-6 have one hour programs shown twice a week and 20 courses in grades 7-12 have one hour programs shown three times a week. No vocational courses are provided during a six-hour school day.

- Scheme IV. An extensive set of programs for the elementary and secondary schools is designed to provide 96 half-hour lessons for vocational education, with the remaining hours devoted to general education.

Total ITV system costs determined include administrative, reception, and distribution costs for the following systems applied to interconnecting public schools in the Appalachian states.

- Local cable with regional microwave interconnections.

- Local cable with regional satellite interconnections.

- Direct satellite reception at each school.
- Local ITFS with regional microwave interconnection.
- Local ITFS with regional satellite interconnection.

In regard to this analysis, understanding the approach used should be considered as important as the results obtained. For this reason, unit cost models employed are explicitly presented in detail in Appendix A. Furthermore, in Appendix B, the specific calculations as they pertain to the Appalachian State region are described.

There are four elements in every cost analysis which can be handled more or less independently: (1) the communication hardware, (2) the administrative costs, (3) programming costs, and (4) value of teacher time saved by delivery of lessons by instructional television. The analyses presented in this chapter and in the appendices are meant to be definitive in principle, but the specific details are not meant to be considered the best nor even rich enough in variety to meet the practical conditions well.

Once the geography is specified and the channel capacity and recording and playback capacity to each school is determined, the hardware characteristics and costs are fairly well defined. For example, direct reception from satellites is most advantageous in the dispersed and remote areas, and local distribution such as cable television or ITFS are more favorable for more densely populated areas. Also, it is important to note that the whole system would, in practice, use several kinds of local distribution schemes involving, for example, cable in densely populated areas and, possibly, direct satellite reception at each school building in remote areas. Such combinations are obviously feasible because they are compatible and are almost certainly to be chosen for implementation.

The administrative cost estimates have wide variation in their make-up. At early stages, there will be much orientation and demonstration to do. In later stages, the coordination will be much simpler. Most uncertainty attaches to the local administrative costs.

Because of the magnitude and uncertainty of local administrative costs, we want to point out some important funding considerations. There are two factors of particular concern:

- During implementation, administrative costs will most likely have to be added in to local school budgets. Once the system has been in operation long enough for teacher cost savings to be realized, however, local budgets should be able to bear all the system costs.

- In the routine operation of the ITV system, teachers can possibly assume many of the administrative functions in day-to-day operation.

The first point requires that supplemental funding be provided until the implementation phase is over. The second point requires careful planning to provide for the transition of some teachers from their instructional responsibilities to administrative.

It should be noted that the idea of placing teachers, properly trained, into ITV administration is attractive because it provides for the coordination between media and instruction described as important by the Commission on Instructional Technology (Table II-7).

Programming costs are uncertain, but in every instance, they are relatively small. Whether one utilizes one set of lessons at the $60,000 per hour level or a set of ten parallel lessons at $6,000 per hour, the costs will be easily met by the budgets suggested. Again, variety and adaptability of the approach is the vital point.

Finally with regard to savings in teacher time, there are great variabilities. In the early stages of implementation, actual dollar savings will be hard to realize. Teaching staffs will not be abruptly cut nor will teacher time be easily rescheduled. As ITV becomes an integral part of school programs, the overall level of teacher time will be substantially reduced. Particularly in large systems with several classes in parallel and with very flexible programming schedules will it be easy to cut the teacher time required? Other important considerations such as replay for remedial lessons or for additional lesson variety have not been considered in the cost analysis.

B. Cost Savings for Selected Educational Programs Using ITV

In this section, we describe cost savings that might be achieved if the ITV systems mentioned were to be used in the improvement and expansion of vocational education opportunities in Appalachia. The savings are the differences between what would be spent if the necessary improvement and expansion were done by conventionally hiring more teachers versus using ITV to reduce future teacher manpower requirements in Appalachia.

There are two cost savings models which we use: ITV in major courses with multiclass enrollments in a school, and ITV in minor courses with single classes taught in a school.

1. Large Enrollment Model

The first model, for multiclasses, is based on the experience of Anaheim and Santa Ana, California, in their use of ITV. In these cases, each class of 25 spends a half day with one teacher in a home room. The other half day is spent in a resource room for ITV where there are two teachers and a teacher aide for every 100 students. This means that the use of ITV provides a saving equal to the difference between the salaries of four teachers and two teachers plus an aide.

A conservative (low) estimate of present teacher salaries in Appalachia was made by reducing the 1970-71 average national in the same proportion that Appalachian teacher salaries were below the national average in 1968-69 (Ref. 7). Combined with a mean Appalachian teacher's day of 7.4 hours (Ref. 7) and a school year of 180 days, this gives a per hour salary of about $6.40.

A high value of 50% of the teacher's salary was assumed for a teacher aide, based on information from the Santa Ana schools (Ref.34). The saving per hour of ITV is then $9.60, or:

$$\text{Savings per student hour} = \$.096 \qquad \text{(V.1)}$$

2. Low Enrollment Model

The second cost saving model is for low enrollment courses. Here it - assumed that the teacher need not be present for the time of the TV program but can turn the class over to a teacher aide. The cost saving per pupil per hour is thus a function of the pupil-teacher ratio and the difference in salary between a teacher and an aide. Based on our previous assumptions, the saving per pupil per hour is given by the following equation where p is the pupil-teacher ratio:

$$\text{Saving per pupil per hour} = \$3.20/p \qquad \text{(V.2)}$$

The assumption of an aide substituting for a teacher in a low enrollment course may not be valid for at least two reasons. For one thing, there may not be enough aides to staff the schools and permit substitution for all ITV courses. Also, in some situations, the teacher may not wish to leave the class during the programming. The case where substitution of an aide appears reasonable is when the teaching position is part-time. Table V-1 shows that there is a relatively high national percentage of part-time instructors in vocational education. This would indicate flexibility in the use of teacher time and support the possibility of substitution. Whether or not the substitution would take place on a large scale would have to be determined in more detailed surveys of the Appalachian region.

3. Programming Costs

Two levels of programming costs are considered here:

- Basic elementary and secondary courses with large enrollments are assumed to have high quality programs costing $60,000 per hour. These programs would have national use, and the Appalachian states, with 1/3 of the nation's pupil populatior - uld have to bear only 1/3 of the cost. Amortized over three ye at 5% interest, the per hour cost is $7,340.

Table V-1

NUMBER OF FULL-TIME AND PART-TIME TEACHERS IN SECONDARY VOCATIONAL PROGRAMS IN U.S. (REF. 3)

	Total	Full-time	Part-time	% Part-time
Total	118,919	89,946	28,973	24.4
Occupational programs:				
Agriculture	10,382	8,653	1,729	16.7
Distribution	6,023	4,590	1,433	23.8
Health	2,146	1,642	504	23.5
Homemaking	27,103	21,688	5,415	24.9
Home economics (gainful)	2,958	1,698	1,260	42.6
Office	32,566	23,716	8,850	27.2
Technical	1,241	1,023	218	17.6
Trades and Industry	24,679	19,584	5,095	20.6
Other	2,515	1,664	851	33.8

- Vocational education courses with small enrollments are assumed to have medium quality programs costing $6,000 per hour. The corresponding per hour cost is $734.

4. Possible Combinations of Pr rams

We are primarily concerned with providing a higl y dispersed population with vocational education instruction. To accomplish this, we examine four schemes for providing this instruction which vary in the size of the vocational education component versus conventional courses. In this analysis, programming for a four channel ITV system will be assumed. This four channel system provides an upper limit of 24 programming hours per school day, assuming a six hour day.

a. Scheme I. (All Vocational Education)

This assumes that all available 24 hours per day are for small enrollment courses as typical for vocational education (see discussion in Chapter II). With a regional total of 20,000 students each and pupil-teacher ratio of 5, we have an expected cost saving using Equation (V.2) and the entire ITV system capacity of:

Annual savings = (Saving per student hour)(No. of students)(No. of hours)

= ($3.20/5) X (20,000) X (1080 hrs/channel-year X 4 channels)

$$= \$55.2 \times 10^{6} \text{ per year} \quad (V.3)$$

Programming costs at $734 per hour for 4320 hours yearly are $3.1 million, giving net savings of $52.1 million.

b. Scheme II. (Half Vocational Education and Half Basic Secondary Education Courses)

Basic secondary education courses such as science, math and English courses can be considered large enrollment courses. From Equation (V.1), a single program of one hour per week reaching 1,000,000 students in classes of 25 each grouped into resource rooms realizes annual savings of:

$$(\$.096 \text{ per student hr}) \times (1{,}000{,}000 \text{ students}) \times (36 \text{ hrs}) = \$3.46 \times 10^{6} \text{ per course.}$$

In the secondary schools alone, we might find 5 such courses in each of the ninth and tenth grades, and 4 in the eleventh and twelfth grades which could use ITV one hour per week. The annual cost savings in the basic courses is:

$$(18 \text{ courses}) \times (\$3.46 \times 10^6 \text{ per course}) = \$62.3 \times 10^6$$

We assume that because of the large audience, these courses would be shown three times a week, using 54 hours of the total of 120 available. This leaves 66 hours for the low enrollment vocational education courses with regional enrollments of 20,000 students each and 5 pupils per class. Assuming a teacher aide is able to substitute for the teacher, we realize savings of 66/120 times the savings in Scheme I, or $\$30.4 \times 10^6$. The total savings using Scheme II are therefore:

$$\begin{aligned}\text{Total Annual Savings} &= \text{Basic Course Savings} + \text{Vocational Education Savings}\\ &= (\$62.3 \times 10^6) + (\$30.4 \times 10^6)\\ &= \$92.7 \times 10^6 \qquad \text{(V.4)}\end{aligned}$$

Programming costs are:

$$[(54 \text{ hrs/wk} \times \$7340/\text{hr}) + (66 \text{ hrs/wk} \times \$734/\text{hr})] \times 36 \text{ wks} = \$16.0 \times 10^6$$

so net savings are:

$$(\$92.7 \times 10^6) - (\$16.0 \times 10^6) = \$76.7 \times 10^6 \text{ per year}$$

c. Scheme III. (All Basic Secondary and Elementary Education Courses)

In this scheme, we consider heavy usage of the systems by basic course users to get an upper value for cost savings. For the first six grades, we assume 5 hours of programming will be produced each week for each grade level. Using the estimates of $\$3.46 \times 10^6$ per course ITV hour derived in Scheme II, we estimate annual savings of 30 courses X ($\$3.46 \times 10^6$ per course) = $\$91.4 \times 10^6$. These grade levels should not experience the scheduling problems of high school and therefore the program will be scheduled only twice a day, using 60 of the available 120 programming hours each week. If we teach 20 basic course hours between the grade levels of 7-12, we obtain an additional cost savings of:

$$20 \text{ courses} \times \$3.46 \times 10^6 \text{ per course hour} = \$69.2 \times 10^6.$$

Allowing each of these programs to be shown three times during the week, uses up the remaining 60 program hours. The total annual cost saving would be:

$$\begin{aligned} \text{Annual Cost Savings} &= \text{Basic Elementary} + \text{Basic Secondary} \\ &= (\$91.4 \times 10^6) + (\$69.2 \times 10^6) \\ &= \$160.6 \times 10^6 \end{aligned}$$

Programming costs are:

$$50 \text{ hrs/week} \times \$7340/\text{hr} \times 36 \text{ weeks} = \$13.2 \times 10^6 \text{ per year.}$$

Net savings are therefore:

$$(\$160.6 \times 10^6) - (\$13.2 \times 10^6) = \$147.4 \times 10^6 \text{ per year.}$$

Vocational education users on a system such as this would probably have access to the system after regular school hours but in this respect they would be secondary users.

d. Scheme IV. (A High Use System to Deliver Elementary and Secondary School Courses with Substantial Vocational Education Options)

The foregoing programming models have not depicted particular schedules or proportions of courses among grades. Let us now consider a different system which delivers eight lectures per week to all elementary school students and nine lectures per week to all high school students. The lectures are each assumed to be twenty-minute lessons scheduled on half-hours. Suppose that all students in each of the first four grades get only one option. Students in the middle four grades get two options. High school students are assumed to divide equally into vocational education students and college preparatory students. In each year of high school, each student will get three lessons per week which are common to all students in his grade. He will get three more lessons common to all students in the college preparatory option (or common to all students in the vocational education option). The remaining set of three lectures will be chosen from two optional sets for college preparatory students or from eight optional sets for vocational education students.

Once such a lesson plan is selected, one can develop the numbers of lessons to be delivered, hence the programming costs, the class sizes, and the dollar value of the teacher time saved. The calculations are given in detail in Appendix C and are summarized in Table V-2. The costs per hour of vocational option courses were assumed to be $6,000. Costs were amortized over three years at 5% interest and one third of the costs were allocated to Appalachian states.

The significant consequences of this example are these:

- By heavy utilization of the channels, the delivered number of student lessons is very high and the system has large saving in teacher time.
- The vocational education option courses use very r· ,n channel capacity but don't add much programming cost.
- Class size for vocational education options are very small.

C. ITV Systems Designed for Appalachian States and Their Costs

The educational programs of Schemes I and II are designed for high schools only. Schemes III and IV are for both elementary and secondary schools. Therefore, we consider two different delivery system designs: one with the capability of delivery to all public secondary and elementary schools in the Appalachian states and the other, to secondary level schools only.

Costs of the five ITV systems were developed from models and cost estimation data described in Appendix A. The computations of the costs are de ·ribed in Appendix B, ·ng with the demographic data used to determine results for the Appalachian s ... One item of particular interest in Appendix B is the estimation of existing facilities such as ITFS facilities, cable networks, and classroom televisions. These represent capital investments that do not have to be duplicated by a new system.

Table V-2

CHARACTERISTICS OF A 4-CHANNEL SYSTEM DELIVERING 8 LECTURES/WEEK TO ELEMENTARY STUDENTS AND 9 LECTURES/WEEK TO HIGH SCHOOL STUDENTS

Grade Category	Student Lessons/week	Number of Options	# Lessons/wk/grade	# Lessons/week for all grades
First 4 grades	8	1	8	32
Middle 4 grades	8	2	16	64
High School common course	3	1	3	12
High School Voc. Ed. common course	3	1	3	12
High School College Prep. common course	3	1	3	12
High School Options common course	3	2	6	24
Total lessons/wk (High enrollment courses)				156
High School Voc. Ed. Options	3	8	24	96
Total lessons/wk				252

(For half-hour scheduling 1 channel can carry 60 lessons)

Channels Needed - 4.2

Programming Costs - $14.60 X 10^6$

Value of teacher time saved = Student hrs/yr in Non-Voc. Ed. Option courses X 0.096 = $203 X 10^6

Class size in a 500 student high school f : a Voc. Ed. Option course - 8

Lectures are 20-minute lectures scheduled at half-hour intervals.

For the five systems described in the introduction, we have the cost results displayed in Table V-3 for the all-school system and Table V-4 for the secondary-school-only case. The cost components listed are defined as follows:

- Administrative costs include local supervision at the ITFS or cable system level along with that for providing state and regional coordination.

- Reception refers to school internal wiring and purchase of TV sets as needed.

- Distribution consists of both local distribution costs in the case of CCTV and ITFS and long haul interconnection costs using microwave or satellite as indicated.

- The inclusion of VTR centers in the direct satellite receive system was to allow for costing out a dimension of increased scheduling flexibility when considering this system. This was felt necessary to make it comparable to CCTV and ITFS systems since these systems allow local access to origination. The VTR centers described are placed at each school and consist of four VTR's, a tape library and an operator.

Administrative costs are on the same order of magnitude as distribution costs but are much more uncertain. Therefore, the two categories are listed separately and can be readily changed on the basis of new information.

D. Cost Results

The results of this analysis are summarized in Figure 5.1 The satellite provides for the least expensive system both when used directly and as the means of interconnection between ITFS and cable systems. By going from an all-school system to a secondary-only system, we obtain the greatest cost reduction in the direct satellite system with the VTR centers. This results from the overriding costs of the school-based VTR centers on overall costs. The cable system with satellite interconnection is next in cost reduction followed by the direct satellite receive system without VTR. The ITFS shows the least cost reduction.

In order to vary the area of coverage as a parameter in order to get a feel for how the cost comparisons vary with size of the region, the Appalachian state region was scaled down in equal state increments. The resulting cost curves which display the variable and fixed components of the distribution system costs

Table V-3

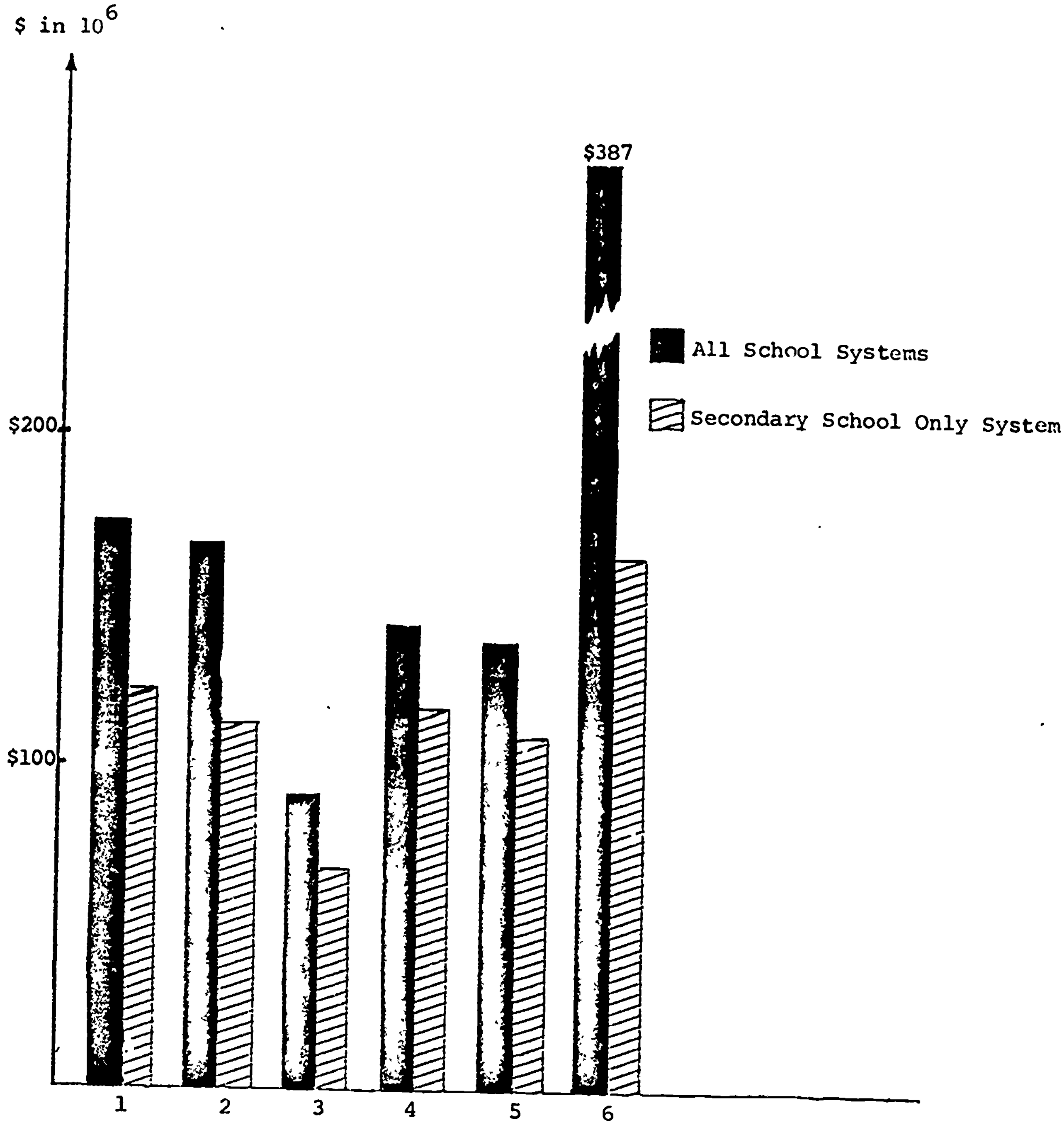
TOTAL BASIC COSTS FOR APPALACHIAN STATE FOUR CHANNEL ALL SCHOOL INTERCONNECTION SYSTEMS (in millions of dollars per year)

Cable with microwave	
Administrative (Table B-6)	$51.8
Reception (Table B-7)	28.7
Distribution (Table B-8)	96.1
Total Annual Cost	$176.6
Cable with satellite	
Administrative (Table B-6)	$ 51.8
Reception (Table B-7)	28.7
Distribution (Table B-8)	87.6
Total Annual Cost	$168.1
Satellite	
Administrative (Table B-6)	$47.6
Reception (Table B-7)	28.7
Distribution (Table B-8)	17.4
Total Annual Cost	$93.7
VTR Centers	$293
ITFS with microwave	
Administrative (Table B-6)	$47.6
Reception (Table B-7)	28.7
Distribution (Table B-8)	63.5
Total Annual Cost	$139.8
ITFS with satellite	
Administrative (Table B-6)	$47.6
Reception (Table B-7)	28.7
Distribution (Table B-8)	55.7
Total Annual Cost	$132.0

Table V-4

TOTAL BASIC COSTS FOR APPALACHIAN STATE FOUR CHANNEL SECONDARY SCHOOL ONLY INTERCONNECTION SYSTEM
(in millions of dollars per year)

Cable with microwave	
Administrative (Table B-6)	$51.8
Reception (Table B-9)	14.7
Distribution (Table B-10)	57.4
Total Annual Cost	$123.9
Cable with satellite	
Administrative (Table B-6)	$51.8
Reception (Table B-9	14.7
Distribution (Table B-10)	48.9
Total Annual Cost	$115.4
Satellite	
Administrative (Table B-6)	$47.6
Reception (Table B-9)	14.7
Distribution (Table B-10)	9.4
Total Annual Cost	$71.7
VTR Ce ters	$84.7
ITFS with microwave	
Administrative (Table B-6)	$ 47.6
Reception (Table B-9)	14.7
Distribution (Table B-10)	52.9
Total Annual Cost	$115.2
ITFS with satellite	
Administrative (Table B-6)	$47.6
Reception (Table V-9)	14.7
Distribution (Table B-10)	44.7
Total Annual Cost	$107.0



Key:
1) Cable with Microwave
2) Cable with Satellite
3) Satellite Direct Reception
4) ITFS with Microwave
5) ITFS with Satellite
6) Satellite Direct Reception with VTR Center at Each School

Figure 5.1 TOTAL ANNUAL SYSTEM COST
(Administration, Reception and Distribution)

are displayed in Figure 5.2, showing the distribution cost components only. Two curves for the direct satellite reception curve are plotted with and without replay (VTR) capability at each school. A replay capability at each cable or ITFS center has been included. It's not a substantial component of the total costs. For the satellite direct broadcast, we see again how expensive the VTR replay facilities are when added to each school or compared to the case when added to local ITFS and CCTV distribution centers. Therefore, from the standpoint of flexibility in scheduling and local origination, the ITFS and cable systems appear much less expensive. The cost breakpoint between terrestrial microwave and satellite occurs for geographic coverage of a single state. For purposes of this homogeneous analysis, the single state is scaled to have an area of 40,000 sq. miles and a student population of about 1,000,000.

The variation of the distribution cost with number of channels for the Appalachian state systems which have been described is given in Table V-5. The variation in channel capacity over the range considered is seen to have a substantial effect on cost although some economies of scale are being realized.

E. Conclusions

This chapter completes the picture for a comparison of total ITV system costs to possible cost savings in its application in various educational programs. Total ITV system costs include administrative, reception, and distribution costs for the following systems:

- Cable with microwave interconnection
- Cable with satellite interconnection
- Satellite direct reception at each school (with and without VTR centers at each school).
- ITFS with microwave interconnection
- ITFS with satellite interconnection

The cost savings expected using ITV with each of the four schemes discussed in Section B, and the cost of each basic delivery system are summarized in Figure 5.3. Dashed horizontal lines indicate the savings from using each scheme and vertical bars show estimated cost for each delivery system in Appalachia.* Two costs are indicated for each system, one represents ITV reception by all

* Achievable cost savings may vary from system to system as a function of factors such as replay flexibility.

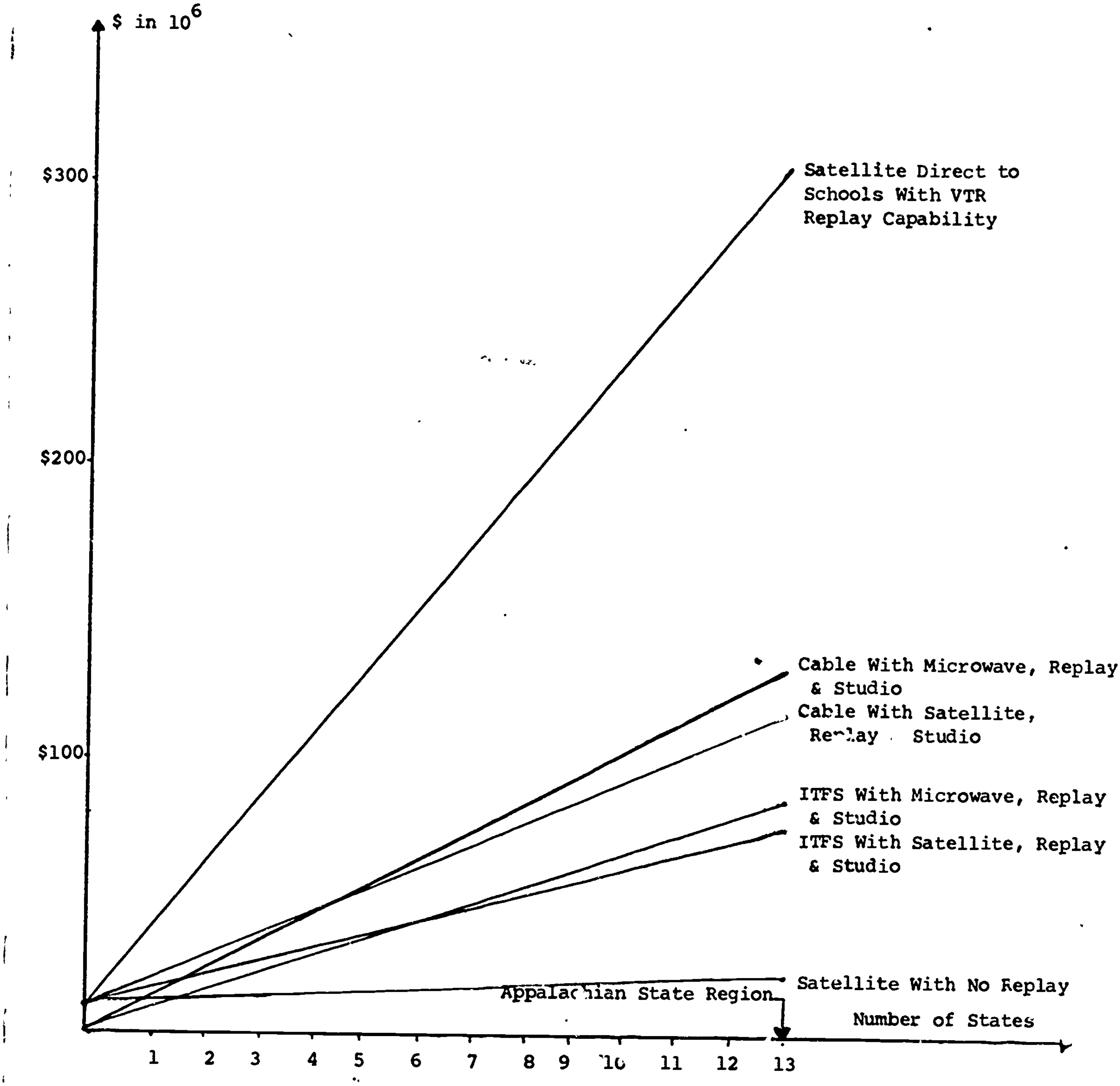


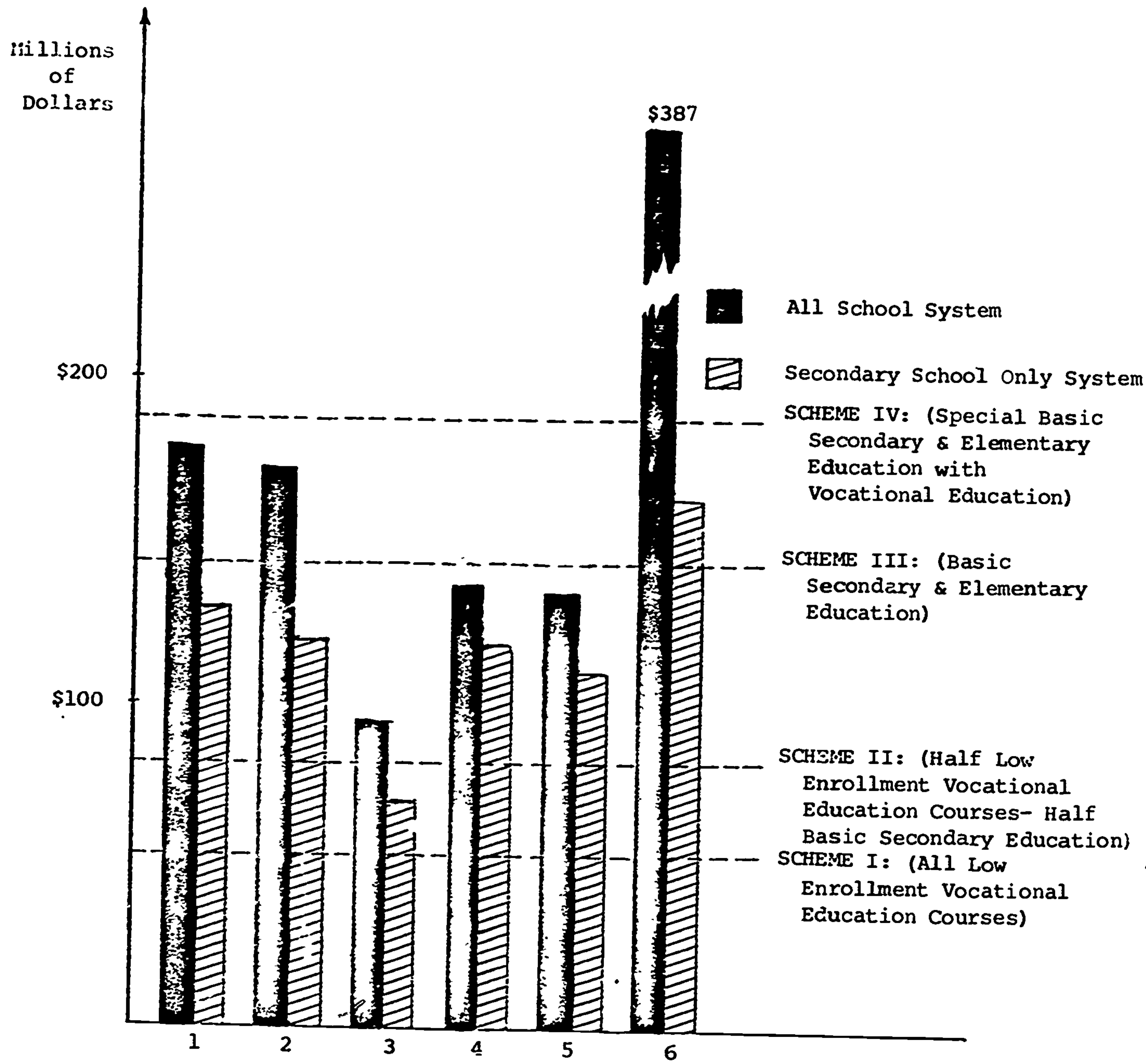
Figure 5.2 DELIVERY SYSTEM ANNUAL COST COMPARISONS
(Four Channel ITV System, Serving All Schools)

Table V-5

SUMMARY OF DISTRIBUTION COST EXAMPLE RESULTS
FOR VARIOUS CHANNEL CAPACITIES
(Annual cost in millions of dollars)

System Description/Channels	All Schools* 1	2	4
1. Cable with microwave intercon.	$53.3	$70.0	$96.1
2. Cable with satellite intercon.	48.9	64.6	87.6
3. Satellite direct receive	9.1	11.9	17.4
4. ITFS with microwave intercon.	41.7	48.9	63.1
5. ITFS with satellite intercon.	37.4	43.1	55.7

*For reception costs including wiring of schools, TV sets, etc. add $\$12.7 \times 10^6$ for additional facilities accounting for those existing.



Key:
1) Cable with Microwave
2) Cable with Satellite
3) Satellite Direct Reception
4) ITFS with Microwave
5) ITFS with Satellite
6) Satellite Direct Reception with VTR Center at Each School

Figure 5.3 TOTAL ANNUAL SYSTEM COST
(Administration, Reception and Distribution)

public elementary and secondary schools and the other reception by a system serving only the secondary and combined schools. For comparative purposes, the total annual expenditures in 1970 for vocational education in the Appalachian states is $762 million of which the Federal government contributes $108 million (Ref. 6). Therefore, these telecommunication systems being considered represent an annual investment in excess of 10% of the present total vocational education budget in the Appalachian states. When considered in the light of the total public secondary and elementary education spending in the Appalachian states in 1970-71 of $14.8 billion dollars, the telecommunication systems under discussion represent on the order of 1/2 to 1% of the total spending level for secondary and elementary education.

From Figure 5.3 and the preceding analysis, the following conclusions may be drawn based on the systems and estimation procedures described:

- The estimated cost savings from Scheme I for teaching all lower enrollment vocational education courses over the systems is smaller than the costs over all systems considered.

- Scheme II for teaching 60 hours of vocational education courses over the ITV system and allocating 60 hours to basic secondary education courses saves more than it costs only on the direct satellite receive system when limited to secondary school reception.

- Teaching only basic elementary and secondary education courses as described in Scheme III produces the greatest cost savings. The satellite and ITFS systems appear cost effective for this scheme. However, vocational education users would only get access to the system outside of normal school hours.

- Scheme IV: The significant consequences of this example are these:

  (1) By heavy utilization of the channels, the delivered number of student lessons is very high and the system has large saving in teacher time.

  (2) The vocational education option courses use very much channel capacity but don't add much programming cost.

  (3) Class sizes for vocational education options are very small.

- Administrative costs which contain a large amount of uncertainty are estimated on the same order of magnitude as delivery system costs.

- The breakeven point for direct satellite reception by public elementary and secondary schools when compared to terrestrial interconnection systems is around the size of a state of 40,000 square miles containing 1,000,000 students.

Chapter VI

IMPLEMENTATION

In this section we consider problems of implementing a system over a large geographic area. There are three major considerations:

- Acceptance on the part of teachers, students and parents is crucial for successful implementation and has been a major obstacle in previous attempts to use technology in education.
- Broad area cooperation must resolve problems of
  - selecting a common curriculum among the states to be covered,
  - scheduling programs to match local needs, and
  - providing for local programming in instructional areas with unique local characteristics.
- The expansion of local and state broadcast facilities has to be accomplished in a way that assures compatibility over a multistate region.
- Initially the implementation will not realize cost savings in reduced teacher time. Until the system realizes a state of equilibrium, additional funds over normal operational needs must be provided.

We can expect a significant degree of uncertainty in the ability of any one plan or combination of plans to provide a workable approach. Demonstrations will be required which will make local educators aware of the potential of ITV and test concepts for an effective operational system. We will therefore consider the implications for the demonstration design of the problems of acceptance, broad coverage and ITV facilities expansion.

A. Acceptance

In the section on the Implications for Service Programs, we gave a brief overview of the benefits of instructional technology and problems preventing its effective implementation. The problems we must consider that are directly related to the acceptance issue are:

- teacher indifference and antipathy
- quality of programming

- accessibility of materials and equipment
- teacher training
- joint involvement of teachers and media specialists in planning.

With the ITV systems we are studying, there is precedence for successful resolution of the acceptance problem. In cases where teachers have been deeply involved from the beginning (1) to understand better the role of ITV in the classroom and (2) to plan the scheduling and content of the material presented, the use of ITV has been accepted and successful. Anaheim and Santa Ana, California, Hagerstown, Maryland, and Dade County, Florida are examples. By providing quality programs properly integrated into the curriculum, student acceptance can be realized. The resulting achievements have been shown to be at or above the levels attained under conventional instruction (Ref. 25 and 35), so parental support is not a major problem. Hence, by developing a high quality instructional package and involving the teachers in that development, we can expect to deal with local acceptance of the use of ITV.

B. Broad Area Coverage

The problem of acceptance becomes more complicated when we talk about programming over large geographic areas. The quality of programs and their content have to be agreed upon by a large number of people from many states and communities. In addition, schedules are more difficult to coordinate as the number of schools increases. Finally, there will probably be local programming needs that cannot be met by a regional system. Unless these problems are resolved, we cannot expect a multistate system to be feasible.

Provided that ITV constitutes on the order of 20% of the instructional time in school, and is restricted to standard content areas, regional agreement should be realizable on program content. It will be necessary to provide a mechanism for incorporating teacher inputs into the planning process. Given the size of the region we are considering - 13 states - it is unreasonable to expect every teacher to become directly involved in planning. However, routine review of comments and suggestions from teachers would have to be made an integral part of the ITV system's operation. Also, by spending sufficient sums on the development of programs to insure high quality, there should be an incentive for local teachers to use the material. Finally, if the ITV system can be implemented on the basis of 20% use, then there should be enough time in the remainder of the instruction for a teacher to shape the curriculum as desired.

In some vocational courses, it may be necessary to provide almost complete scheduling of the lecture portion for ITV. This would be true for highly specialized courses which a' . to be taught in remote locations without the assistance of an instructor expert in the field. In these cases, it may be desirable o broadcast the complete lecture portion of the course. Schools with qualified lecturers could use the programs selectively to supplement existing lectures, and probably substitute up to the present practice of broadcasting about 20% of the course time. Schools without qualified personnel could use the entire program, with teachers from other fields acting primarily as monitors.

Scheduling is a serious problem. In local areas such as Santa Ana, California, a program is replayed up to six times a day to provide flexibility for individual schools. Over a 13-state region, there must be some provision for a high rate of replay. This option has been provided for in this study by either including local VTR capability or by consideration of expanding satellite capability from 4 to 24 channels. A 24 channel system in a satellite would permit 6 showings a day of each progr am.

C. Facilities

In the 13 'ppalachian states, there is an extensive UHF broadcast network for educational television. ITFS and cable systems are not as extensive, but their use is growing. Our concern here is that existing facilities be used where possible for demonstration and implementation. Any decision on final ITV system configuration must a ount for facilities that are developing to meet local demands at the present time.

The main reason for coordination is that without it a large number of local systems might be incompatible with the desired regional system. Another, and related reason, is that the resources already gathered for systems now in implementation are a potential source for building the overall system. It is necessary to coordinate development if those resources are to contribute to the larger system and the need for additional resources is to be minimized.

D. Immediate Financing

Part of the argument to use ITV is that it can be self-supporting, i.e., savings in teacher salaries can cover the costs of the system. This is true for the system that has been in operation long enough for the school system to adjust its staffing pattern. Such adjustments are realized through the natural turnover and retirement of teachers. Until the point is reached where available personnel match the needs of a system using ITV, some proportion of the costs of ITV will have to be borne by supplemental funding. Hagestown, Maryland, relied on the Ford Foundation for support for the first five years of its operation. From that point on through another 12 years, the system has been self-sustaining (Ref.19).

Implementation plans should include, therefore, provision for funding the use of ITV where cost savings are not yet realized.

E. System Implementation

There are two general approaches to the development of a regional system:

- Each subregion develops its own art of the system. When extensive coverage is achieved based on local demands, and regional demands develop, the parts can be connected and regional services delivered.
- The alternative is to begin with a regional capability and allow the use of the system to grow as regional demand increases.

The first approach allows for a final system that might be quite different from e one originally envisioned. However, there is a possibility that the grow of programs and the facilities to deliver them might produce elements incompatible with the most desirable regional configuration. For example, the direct broadcast from a satellite to the schools might be preferred. On the other hand, local or state development of ITV might rely on cable or ITFS local distribution with microwave links. Unless there is a way to utilize these local capabilities for other purposes, the satellite might represent too expensive a redirection of the development pattern. So too with curriculum. If each state develops ITV programs for its vocational education system, there may be a commitment too difficult to overcome in reaching agreement on regional standards for the instructional material.

The strength of this approach is that the problem of local or state acceptance of ITV is reduced. As experience is gained with the use of the technology, then better programming and scheduling procedures could result. When it is time to consider regional services, programs can be designed on the basis of a better understanding of the needs.

The second alternative has an attractive feature in that the regional distribution part of the system is a small part of the overall cost. For example, it would be possible to launch and operate a high-capacity satellite and let the use be shaped as the demand develops. Guarantees would have to be maintained that use is regional in nature. Curricula developed for broadcast would have to be used in several states and assurances given that it would be acceptable elsewhere when reception capability is obtained.

The problem with this approach is that it is an early commitment to a problem with significant uncertainties. If, in fact, regional programming could not be accomplished, then the system would not be used and, in the example of the satellite concept, the facilities turned over to another use or not replaced at the end of its operational life.

No recommendation can be made at this time as to which approach should be followed. It is important that further studies focus on this question. Its resolution will significantly affect the design of a development program.

The issues basic to the question of a local versus regional development focus should be dealt with in any demonstration planning.

F. Demonstrations

There are two reasons for designing demonstrations:

- System designs have to be tested to see if they work.
- Demand for services via ITV has to be developed on the basis of performance.

If the regional system is to work, there must be

- Agreement on common curricula.
- Adequate scheduling.

In order to demonstrate that this can in fact be done, a multistate test should be performed. Existing facilities (UHF, ITFS, cable) can be utilized, but a broad area should be covered. A particular course or set of courses should be selected, and teachers and administrators from the states involved should agree on the content. Scheduling problems would have to be resolved by a coordinating committee which could work with all the schools taking part in the demonstration. Enough time should be allowed so that every teacher and administrator directly involved can at least have an opportunity to review and comment on proposed programs.

Hardware problems should be kept to a minimum by not introducing new hardware except for demonstrating feasibility in areas where no hardware exists. Remote rural areas, for example, may not have reception facilities.

The main considerations in the design of demonstrations are therefore, that they be multi-state and that they utilize existing facilities where possible. To demonstrate the shape a demonstration might take, examples are given of possible projects in two states, Alabama and South Carolina. These are representative only, and final selection would be made only after a review of possibilities in all 13 Appalachian states.

Chapter VII

A STUDY OF POSSIBLE DEMONSTRATION PROJECTS

A. Summary

The foregoing sections of this report have indicated several factors which point to the need for instituting demonstration programs:

- Among present experiments, the degree of success in technologically supported education appears to depend in large measure on the public and teacher acceptance of the new technological program. Carefully organized demonstrations in favorable areas would increase the credibility of specific technologically-supported education programs.

- Operational budgets will necessarily be drawn from a combination of Federal, State and local funding. For education, dominant public operational funding will come from local sources. Long-term program choices generally will reside with local agencies. Demonstrations will give them specific evidence on which to make both planning and operational choices.

- Administrative costs for telecommunications-aided education appear comparable to hardware costs. More operational experience is needed to develop administrative procedures particularly in the transitional phases as new programs are introduced. Demonstration projects would provide such operational experience.

- Substantial benefits appear to accrue from combining health occupation education and health-care delivery to dispersed rural populations. Further, combined funding from several federal agencies, several local agencies and regional commissions promises advantages in funding effectiveness. Carefully selected demonstrations could stimulate this joint funding.

An exhaustive review of potential local programs was not done. The following summaries of possible demonstrations are considered representative of programs for which there is local demand and which satisfy a critical need. Before any decision could be made, further assessment of alternatives from other areas would be needed to find the best choice.

The material summarized below has several functions:

- It illustrates the need for a local advocate to integrate complementary desires and forces.

- It illustrates promising alternative demonstrations which may be implemented.

- It illustrates a possible process of local brokerage which we believe is valuable.

- It provides at least three projects which merit further serious consideration.

The specific examples presented below indicate that in common with several other Appalachian States:

- The societal need for education and health care is very great. The states of Alabama, Georgia, and South Carolina appear to be drastically below the national norms in both health care personnel and health care facilities.
- Rural families appear to be substantially less healthy than the national average.
- A combination of health occupation education and health care program development appears desirable.
- Local governments, State governments, and the Appalachian Regional Commission appear able to support such programs.

B. The Need for Telecommunications to Support Health Care Delivery in South Carolina

The disparity in the availability of basic health maintenance and health care services confronting many states is a problem area that could be impacted upon significantly by use of certain components of telecommunications. The use of telecommunications to extend or expand health service capabilities to rural and remote sections may be a way to respond to this vital need. Thus far, however, this problem has not been successfully addressed by training more doctors or by offering inducements to attract doctors into these areas. In fact, it may well be that telecommunications, and such facilities as mobile units, may be the only way this need can be met. It is very difficult, if not impossible, to find sufficient inducements to bring qualified physicians into remote areas where desirable amenities are limited if not totally lacking.

1. South Carolina Has Large Unmet Needs in Health Care

The State of South Carolina represents a unique State for testing the usefulness of telecommunications in helping to solve this fundamental problem - the availability and appropriate distribution of health manpower. In terms of need, it is difficult to point to a State where the need is any more severe. South Carolina, according to the 1968 report of the AMA Department of Survey

Research, ranked 47th among the 50 states in numbers of doctors in patient care per 100,000 population. South Carolina could count only 71.6 doctors per 100,000 against a national average of 119.7. Subtracting the doctors engaged in hospital based practice, moved South Carolina down to 48th with only 60.3 doctors per 100,000 population. Only Mississippi and Alaska ranked lower than South Carolina in this indicator.

A closer look at the 1968 figures shows the health manpower need to be even greater than the overall averages for better than half the population of the State. The four most populous and urbanized counties; Charleston, Greenville, Spartanburg and Richland contain 34% of the population and 48% of the doctors who are engaged in patient care outside of the hospitals. In other words, in South Carolina in 1968, approximately 1,731,800 people outside those four counties were being served by 821 doctors in private practices; roughly 47 doctors per 100,000 people.

According to the same report, South Carolina has a total of 70 hospitals with 9,047 beds. Of these, only 17 were in the largest four counties mentioned above; but they accounted for 3,731 beds, 41% of the total available.

In June of 1972, the Medical University of South Carolina in Charleston, the only medical college in the State, graduated 82 new doctors. For the current year, the projection is 121 graduates, almost a 50% increase. Even if the university continues to increase its output by 50% each year, retains all graduates to practice in the State, and the State population remains constant, by the end of 1975 South Carolina would still not have 100 doctors per 100,000 population. In addition, because of the unattractiveness of many areas where doctors are needed the most, it is quite unlikely that the distribution problem would be significantly affected.

Expenditures for health are also indicative of the health care problems in South Carolina. According to an article by Professor Bauerschmidt in the December, 1969 University of South Carolina <u>Business and Economic Review</u>, South Carolina expenditures for health care were $380.2 million in 1967. During this same year U.S. expenditures were $50.9 billion. Therefore, South Carolina accounted for 0.75 percent of total U.S. expenditures for health care. To place this figure in perspective, it was indicated in the article that South Carolina has 1.31 percent of the U.S. population. This indicates that per capita expenditures for health in South Carolina are nearly half that of the U.S. population as a whole.

2. The Governor Supports Health Care Strongly

Another factor that makes South Carolina particularly suitable for a demonstration of the usefulness of telecommunications in the delivery of health care is the emphasis being placed on this subject by Governor West and some of his key officials. Recent pronouncements by the Governor indicate the following objectives are essential during the balance of his term: (1) A determination of what is minimum acceptable health care, and (2) the delivery of that level of service.

As one component of his executive reorganization, Governor West has emphasized health by specifying one section of his Division of Administration to be dedicated to the development and implementation of an integrated Statewide health care plan. The Director of the Appalachian Regional Commission 202 Health Demonstration area, because of his demonstrated effectiveness in establishing and implementing health care policy and programs in his area, has been charged to head this effort on behalf of the State. Conversations with him and his newly formed staff make it very clear that they intend to follow the Governor's mandate with vigor. They intend to initiate an action plan operating with no "givens" and seeking innovation wherever it appears appropriate and responsive in order to bring minimum acceptable health care to all of the citizenry as rapidly as possible.

3. Federal Support for Health Care Delivery is Growing

Another indication of South Carolina's initiatives can be found in the grants for Comprehensive State Health Planning and in allocation for construction and modernization of hospitals and related health facilities. In the March, 1972 hearings before the House Committee on Appropriations, data are given showing that South Carolina ranks 23rd among the 50 states with $113,500 allocated for Comprehensive Planning in 1971 and $2,996,889 for construction and modernization that same year, excepting those funds under Hill-Burton. In that regard South Carolina in 1971 ranked 30th among the states with 5 projects totaling $3,442,431 of which roughly half were State monies.

4. Manpower Initiatives

In September, 1972, The Medical University of South Carolina initiated a training program for paramedics modeled on the Medex Program in the State of Washington. Fifty students are enrolled in this new program. In addition, the Medical University has expanded its training of physicians with freshman and sophomore classes of 165 and 167 respectively. This compares with the June, 1972 graduating class of 121 physicians. To increase the number of general practitioners, the Medical University has 30 two-year residents in a family practice speciality program that was initiated just two years ago. In Nursing, the University plans to graduate 57 baccalaureate nurses in June of 1973.

5. Legislative and Local Support

A review of the debates and actions of the Legislature last year makes it clear that health care needs in the State are considered a priority, if not the priority, problem to be addressed. Conversations with the Directors of the various Regional Councils of Government (the State's substate regional planning mechanisms), the South Carolina Hospital Association, and the South Carolina Council on Human Relations, also make it quite evident that health care delivery is in the forefront of their thinking.

6. Summary and Suggested Pilot*

In South Carolina, the need is great and it would appear that the prospects for receptivity are quite favorable for demonstrations of the usefulness of telecommunications in bringing basic health care to all people within a relatively short period of time. In fact, in South Carolina it might be concluded that the needs are so great that it is very difficult for concerned officials to be specific about the sort of pilot project that would be most meaningful. However, after discussions with the Governor's Office of Planning at least one general area can be suggested where the utilization of telecommunications could be expected to improve the delivery of health care in the State. The Health Section of the Office of Planning is in the process of developing a plan for a Statewide

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* Pilot project has been discussed with Mr. Arch Lugenbeel of the South Carolina Office of Planning, Health Section who approved it in general. The above would need a more detailed development and approval of other South Carolina agencies before a commitment to implement would be obtained.

integrated health care delivery system. Plans are now being made to assemble background information on needs, resources, and gaps in the present system. In addition, plans are also being developed for coordination with the legislature and state delivery agencies on health delivery subsystems that are candidates for accomplishment in the near term. One of the suggested subsystems is Primary Care Centers in regional hospitals.

In concert with the development of primary care centers, closed-circuit TV could be employed in selected regional hospitals to demonstate its value to the provision of care in rural areas. Such a pilot would relate nicely with the philosophy of statewide integrated health care delivery. Regional referral care could be provided by hospitals in four counties where the majority of the State's health capability is concentrated: Charleston, Greenville, Spartanburg, and Richland. Using closed-circuit TV referral services in these counties it would be ultimately possible to cover most rural sections of the State where health manpower is lacking. However, a pilot in one area should be successfully implemented before expanding to the other three.

The development of such a system in South Carolina could be greatly enhanced by the already existing Statewide open and closed circuit Educational TV (ETV) system. The ETV system in South Carolina is probably one of the most extensive of any state in the Country. In the health area, it has been used on a routine basis by the Medical University for continuing education of physicians, dentists, and nurses.

Experience with this technology in other areas suggests that one directional color TV could be utilized by physician's assistants, paramedics, and nurses to obtain consultation from specialists at the regional hospital. Microwave communications would also be required to transmit audio information such as vital signs, heart and lung sounds via an amplified electronic stethoscope, etc. The TV could be used for such things as viewing the patient, transmitting EKG tracings visually, etc. Depending upon the demand at each rural health center, it may be possible to install fixed antennas and utilize a circulating mobile van to transport camera and communications equipment from center to center. This concept would make maximum use of technology to supplement scarce manpower resources.

Closed circuit TV is just one of the several pilots that could be suggested to expand health care delivery in South Carolina. This concept is suggested since it could facilitate the development of integrated statewide health care delivery, it has been employed in several instances in other areas of the country but not on a statewide basis, and if beneficial it could be used to assist in health care delivery in many rural states throughout the country.

C. Application of Telecommunications to Health Occupations Education and Training in Alabama

1. Societal Need

It is not necessary to build a case for the relative and actual social needs of the majority of citizens of Alabama. This already has been done many times by many agencies. They use slightly different statistics and there is some variance in their analyses, but the picture they paint is essentially as follows:

- 20.7% of all Alabama families fall below established poverty limits. In the 54 predominately rural counties the mean poverty figure is in excess of 40% (Ref. 36).
- Functional illiteracy ranges from approximately 13% in the urban counties to 25% to 35% in the rural counties (Ref. 36).
- The majority of habitable housing units (59%) were built within the past twenty years, while 25.8% were built prior to 1940. Restated, more than one-fourth of Alabama residences are more than thirty years old (Ref. 36).
- 31.6% of the households have no toilet facilities (Ref. 36).
- The U.S. average ratio of physicians (active) to population is 1 to 1316. In the rural counties of Alabama this ratio is an almost unbelievable 1 to 2257 (Ref. 37).
- The U.S. average ratio of registered nurses (active) is 1 to 297. In Alabama this ratio is 1 to 471. In the rural counties it is 1 to 688 (Ref. 37).

Numerous statistics could be given to strengthen the point that Alabama, especially rural Alabama, has social and economic needs as severe as any place in the nation. This is particularly true in the case of health needs. To illustrate just one aspect of this health need, we listed in Table VII-1 the current health occupation manpower needs for a nine-county rural area in west-central Alabama. We believe that this area is typical of the rural areas in the southern states and, perhaps, to most of the rural areas in the nation. These additional health workers are needed to meet the minimum health care requirements of the nine-county area. For additional information on the nine counties, please see the section titled Demonstration Site Description.

Table VII-1

CURRENT HEALTH OCCUPATION NEEDS
IN NINE COUNTY DEMONSTRATION AREA (REF. 38)

Certified Laboratory Assistant	50
Medical Records Clerk	20
Family Practice Physician's Assistant	13
Nurse-Midwife	17
Registered Nurse	35
Licensed Practical Nurse	18
Radiologic Technologist	29
TOTAL	182

From a review of recent studies, reports, and planning documents, and from the results of interviews conducted with persons representing the principal health planning and health education agencies in Alabama, we have concluded that one of the most pressing health needs in Alabama is to increase the number of supportive health occupation workers in the rural areas. As indicated in Table VII-1, supportive health occupation workers are defined as:

Certified Laboratory Assistants

Medical Records Clerks

Family Practice Physician's Assistants

Nurse-Midwives

Registered Nurses

Licensed Practical Nurses

Radiologic Technologists

These personnel, for the most part, would receive their education and training in secondary schools, in vocational-technical schools, in junior colleges, in associate degree programs of 4-year schools, and in on-the-job training programs in hospitals and clinics.

In the past few years several major new programs have been initiated in Alabama to increase the supply of supportive health workers. The emphasis in these programs has been placed on post-secondary education and training. Some examples of these new and expanded post-secondary programs are the Regional Technical Institute for Health Occupations that was established in 1970 as part of the Medical Center of the University of Alabama in Birmingham; the expanded program of health occupation education in the vocational-technical schools and the junior colleges; and the initiation of associate degree programs in health occupations at the 4-year schools.

One of the major weaknesses common to all of the individual programs to incre ·e quantity and quality of health workers is a lack of adequate pre-post-secondary preparation (Ref. 39). It appears from preliminary analyses that the problem of inadequate preparation has two major aspects.

One aspect of the problem relates to a lack of awareness of health occupation opportunities on the part of potential students, and, hence a deficient recruiting and selection program. In the secondary schools, particularly those in rural areas, little emphasis has been given to health related subjects. There has not been a concentrated program to "reach" the potential student. At the present time there are only 70 vocational guidance counselors in the state's secondary schools and not one of these is trained in a health occupation. Selected interviews indicate that high school students generally are not aware of the need for health workers nor of the opportunities available and, therefore, are not adequately motivated. Many tend to look at these occupations as being "dead end".

A second aspect of inadequate preparation deals with academic preparation. This is due, to a great extent, to an almost total lack of laboratory facilities and equipment, visual aids, etc., that could provide some hands-on experience for the students and to a lack of trained health occupation faculty. Again, this condition is especially true in rural areas. This is not to say that there are no facilities nor faculty in the state. There are some outstanding teaching/training capabilities. The problem is one of distribution. All the capabilities are clustered in the metropolitan areas, as are most of the public and private health services. A critical need is to get the technology and training capabilities and the health care delivery capabilities into the rural areas. Ideally, the State would like to train supportive health care workers in their respective communities and motivate them to remain in these communities through job placement and promotional opportunities - the career education concept.

The following discussion illustrates the need to extend the Health Occupations Education (HOE) teaching capability into the rural areas of Alabama.

Only five of the 80 secondary schools that offer health occupation courses have teachers assigned to this functional area as their primary teaching responsibility. In the other 75 secondary schools, teachers who are teaching health occupation courses have primary teaching assignments in the trade and industries curricula. Because much of the teaching load in health occupations in the secondary schools is handled on a part-time, or loan basis, it was not possible to arrive at an exact student/teacher ratio in HOE classes. However, with the data available and with information obtained through interviews with members of the State Vocational-Technical and Higher Education Division, an estimate of 40 to 1 is reasonable. Remembering that in 75 secondary schools there are no teachers assigned primary teaching responsibilities in health occupations, most of the students never come in contact with a health occupations teacher.

The 101 secondary and vocational-technical institutions that offer health occupation courses are located in 46 of the State's 67 counties. No health occupation training is offered in 21 counties. All of these 21 counties are rural and rank high in terms of health problems. The State Department of Education has identified the post-secondary schools that hold a high potential for inaugurating HOE programs. High potential is defined in terms of available school facilities and equipment, available faculty or persons who could be employed as faculty, available health care facilities and the ability to mount an effective student recruitment program. The distribution of the post-secondary schools having a high potential for HOE programs is such that most rural areas are omitted. (In the proposed nine-county demonstration area secondary and vocational-technical schools in only two counties offer health occupation courses. This is due to a shortage of teachers and, in most cases, to a lack of equipment and facilities. Both conditions could be relieved with effective application of telecommunications.)

The State of Alabama has been aware of the major problem of inadequate pre-post secondary preparation. The State, acting through the Vocational-Technical and Higher Education Division of the Department of Education, has initiated, with the beginning of the 1972 school year, a program designed to upgrade the pre-post secondary programs in health occupations education. The new health occupations program is part of a broader program to make health care services available and accessible to all Alabamians on a personal and/or community basis. The broad objectives of the secondary school program are to:

1. Provide an orientation course designed to give the preoccupational student the clearest possible explanation of the health career field.

2. Provide facilities for learning which accept the developmental level of the individual and allow for growth through individual motivation.

3. Promote personal growth by counseling and guidance in career development.

4. Produce graduates who are prepared for entry level employment in supportive health occupations or acceptance in post secondary programs (Ref. 40).

In response to the foreseen employment needs of the broader programs of health service and to give impetus to the new secondary school program, the State Director of Vocational Education has stated, "Our goal in vocational education is to increase the output of licensed practical nurses, registered nurses, and allied health workers to provide fifteen supportive workers for each physician (Ref. 41)."

Expressing this goal in terms of current state-wide health manpower needs as determined by the Alabama Comprehensive Health Planning Administration, there is a need for an additional 3,461 supportive health occupation workers (Ref. 42).

The new secondary school HOE program will help the State meet this need by enhancing the pre-post secondary education and training programs and, thereby, creating greater interest and motivation in the students and, at the same time, give them a better academic preparation. The persons responsible for this program are aware that the traditional approach to initiating a new educational program is slow at best: training teachers, recruiting them to rural areas, constructing facilities, obtaining equipment and teaching aids, etc., and recruiting and selecting students takes time. Proper application of telecommunications could reduce this time from years into months.

2. Specific Proposal Objectives

The overall objective of the proposal is to demonstrate that telecommunications can be a major ingredient in the pre-post secondary education and training of health occupation workers.

This will be achieved through two subobjectives. One, to design, develop, and implement a recruitment and selection program in the secondary schools of a typical rural area. Two, to expand and improve the teaching capability in health occupations in the secondary school systems in this rural area.

3. Technical Approach Suggested

a. Demonstration Site Description

A nine-county area in west-central Alabama is proposed as the site for the demonstration. (See Figure 7.1). All of these counties are classified as rural and are some of the most disadvantaged counties in the nation. Demographic and economic data on these counties are in Table VII-2.

There are health occupation courses being taught in two secondary schools and two vocational-technical schools in the nine-county area. The locations of these institutions are shown in Figure 7.1. The distribution of all secondary, vocational-technical schools, and junior colleges in the State offering health occupation courses is shown in Figure 7.2.

Even though the programs in the nine-county area are extremely limited they can provide a nucleus for an expanded program under the demonstration.

The proposed demonstration area has a total of 318 hospital beds, as listed in Table VII-3. The approximate locations of the hospitals are shown in Figure 7.3. These hospitals and the nursing homes in the area would be used in

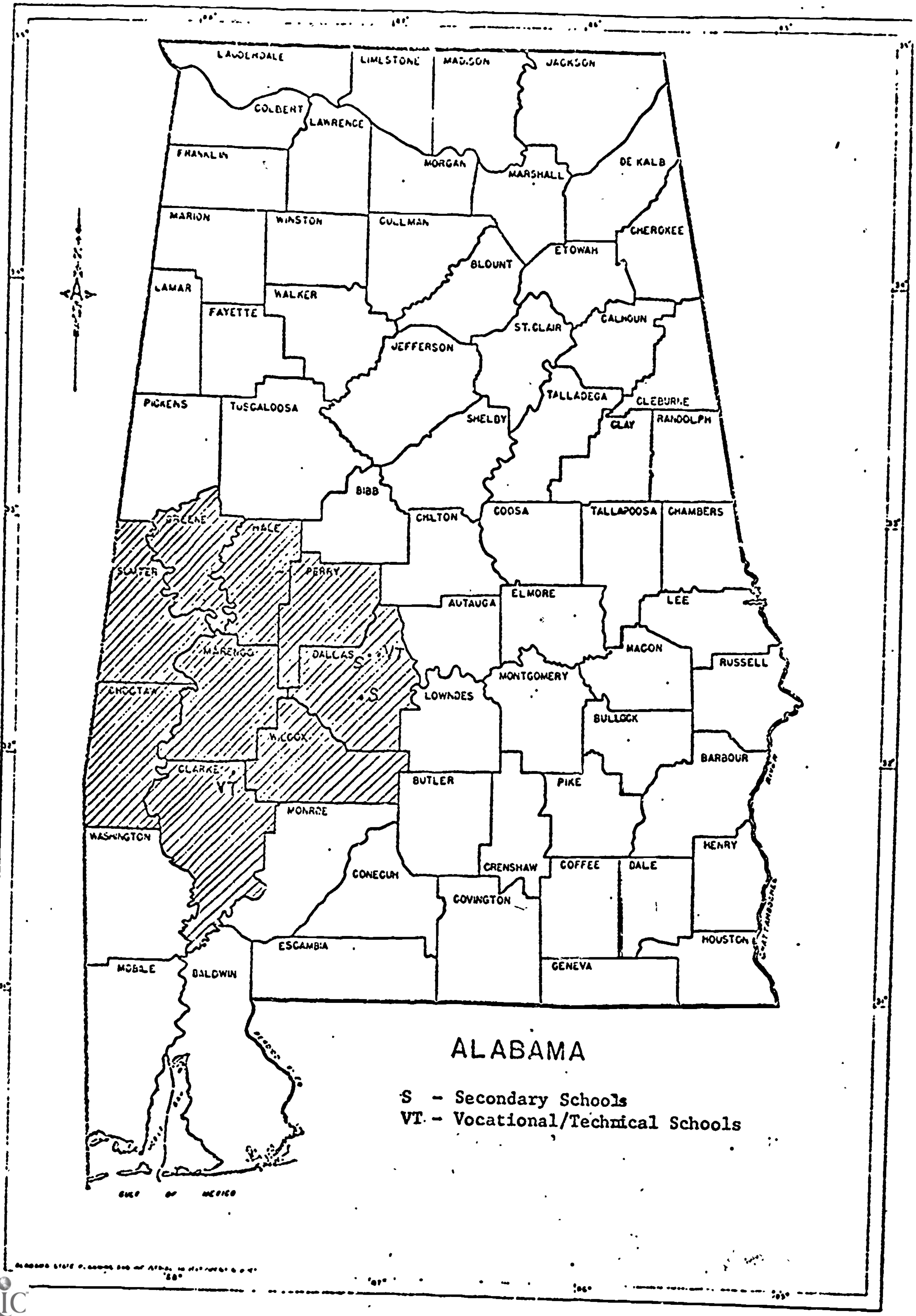

Figure 7.1 NINE COUNTY DEMONSTRATION AREA

Table VII-2

DEMOGRAPHIC AND ECONOMIC DATA ON
NINE COUNTY DEMONSTRATION AREA (REF. 42)

	Total Population	Median Income	Educational Achievement Male	Educational Achievement Female	Severity of Poverty	Functional Illiteracy
Choctaw	16,589	$5,319	8.9	9.7	35.4%	27.3%
Clarke	26,724	$5,900	9.8	10.6	29.8%	22.3%
Dallas	55,296	$5,828	10.6	10.7	31.5%	23.3%
Greene	10,650	$3,034	7.4	8.8	53.6%	38.0%
Hale	15,888	$3,825	7.8	9.0	44.7%	32.0%
Marengo	23,819	$4,909	9.4	9.9	40.2%	29.0%
Perry	15,388	$4,258	8.0	9.0	41.1%	28.7%
Sumter	16,974	$3,938	8.3	9.1	44.9%	36.5%
Wilcox	16,303	$3,917	8.3	9.1	46.4%	32.6%

Alabama Congressional Districts

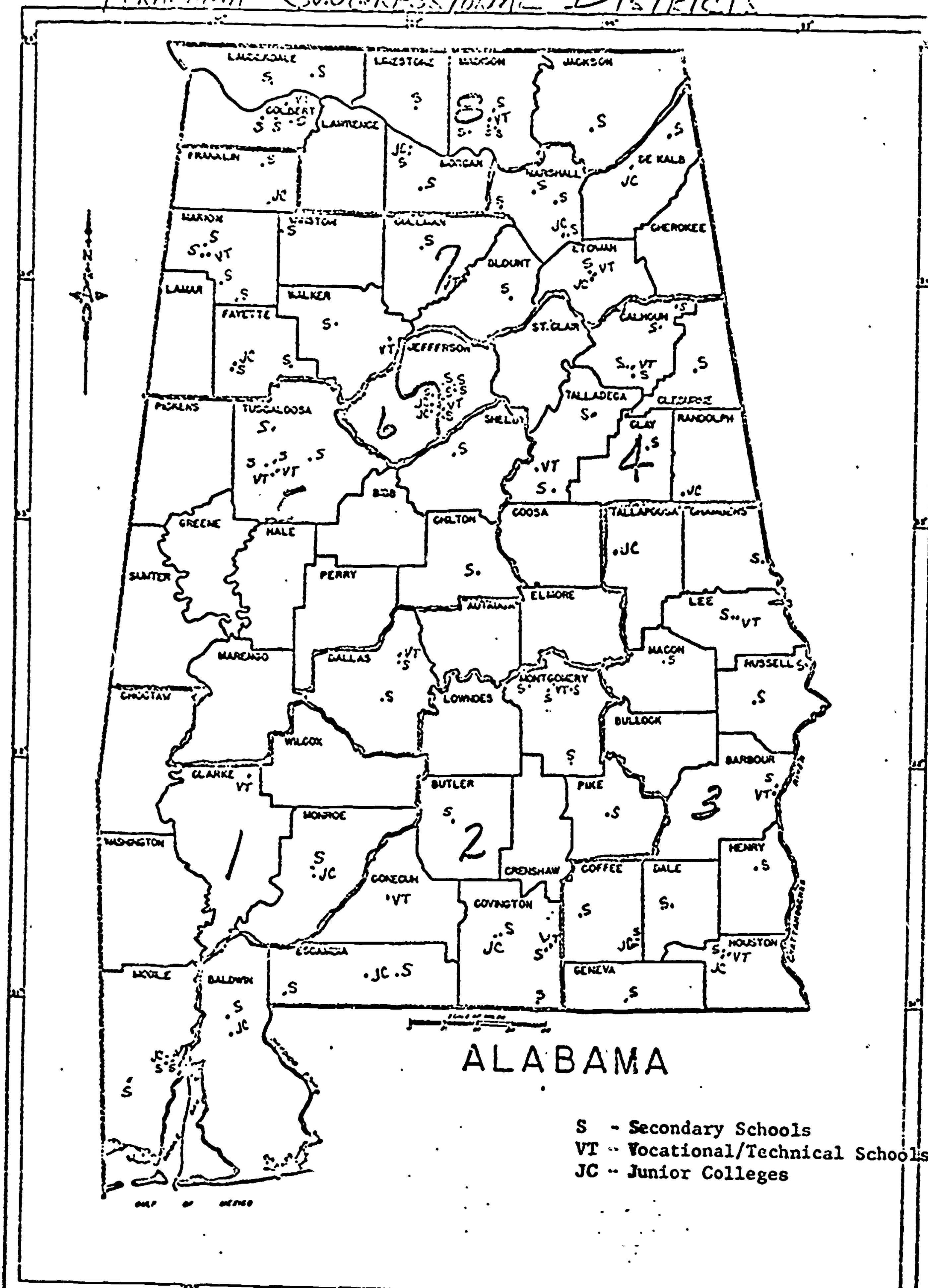

Figure 7.2 DISTRIBUTION OF SECONDARY, VOCATIONAL-TECHNICAL SCHOOLS AND JUNIOR COLLEGES IN ALABAMA

Table VII-3

HOSPITAL BEDS IN NINE COUNTY DEMONSTRATION AREA (REF. 44)

Choctaw	Choctaw County Hospital 63 beds		
Clark	Jackson Hospital 35 beds	Thomasville Hosp. 49 beds	Grove Hill Mem. Hosp. 25 beds
Dallas	Good Samaritan Hosp. 93 beds	Selma Med. Center 105 beds	New Vaughn Mem. Hosp. 64 beds
Green	Green County Hospital 20 beds		
Hale	Hale County Hospital 26 beds		
Marengo	Bryan W. Whitfield Mem. Hosp. 67 beds		
Sumter	Sumter Citizens Hospital 25 beds		
Wilcox	None		
Perry	Perry County Hospital 46 beds		
TOTAL BEDS	618		

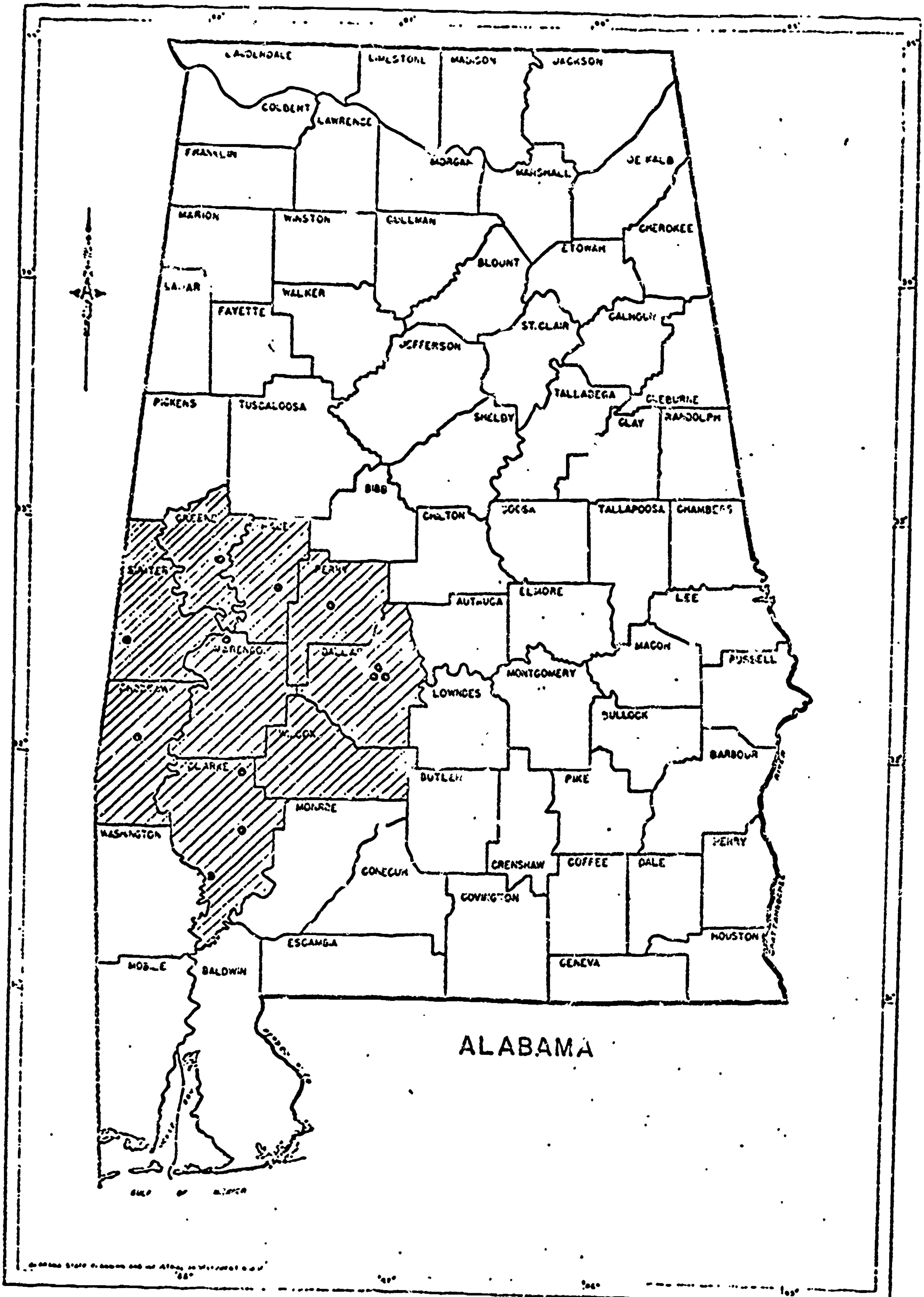

Figure 7.3 LOCATION OF HOSPITALS IN DEMONSTRATION AREA

the demonstration project to give the students some hands-on experience through various work-study and on-the-job training programs.

The area is served by the Alabama Educational Television Network (AETN) through the Station 41 transmitter located in Demopolis in Marengo County. See Figure 7.4 for the configuration of AETN. Marengo County is the approximate geographic center of the proposed demonstration area.

The area was selected because it is typical of many such rural areas in the South and in the Appalachian region. The program developed under this proposed demonstration would have immediate application to the rest of the rural South and to Appalachia.

b. Approach Suggested

The specific tasks to be performed, the details of each, and the assigned responsibilities for the tasks would have to be developed with participation from the several agencies listed below in the section titled Assessment of Human and Technical Resources. The main features of the proposed approach have been discussed with representatives of these agencies and there is general agreement that the proposal is entirely feasible and would be successful. Of particular importance to the success of a demonstration project is the genuine enthusiasm that has been shown by the people who eventually would determine the success of the demonstration. This enthusiasm is due in large measure to the fact that the State has just initiated a secondary school HOE program and the responsible persons see the demonstration project as a means of illustrating a concept similar in many ways to one in which they have wanted to demonstrate but could not because of insufficient resources.

Also of critical importance is the fact that a management/administrative structure already exists within the State Department of Education. That is, the responsibility for the major activities associated with the proposed demonstration-secondary school programs, vocational-technical school programs, junior college programs, curriculum, educational television, and health occupations education planning and supervision - now rest within the State Department of Education. Personnel assigned to these functional activities are working together on a daily basis and under an effective management/administration arrangement. It would be relatively easy to put together a task force capable of successfully

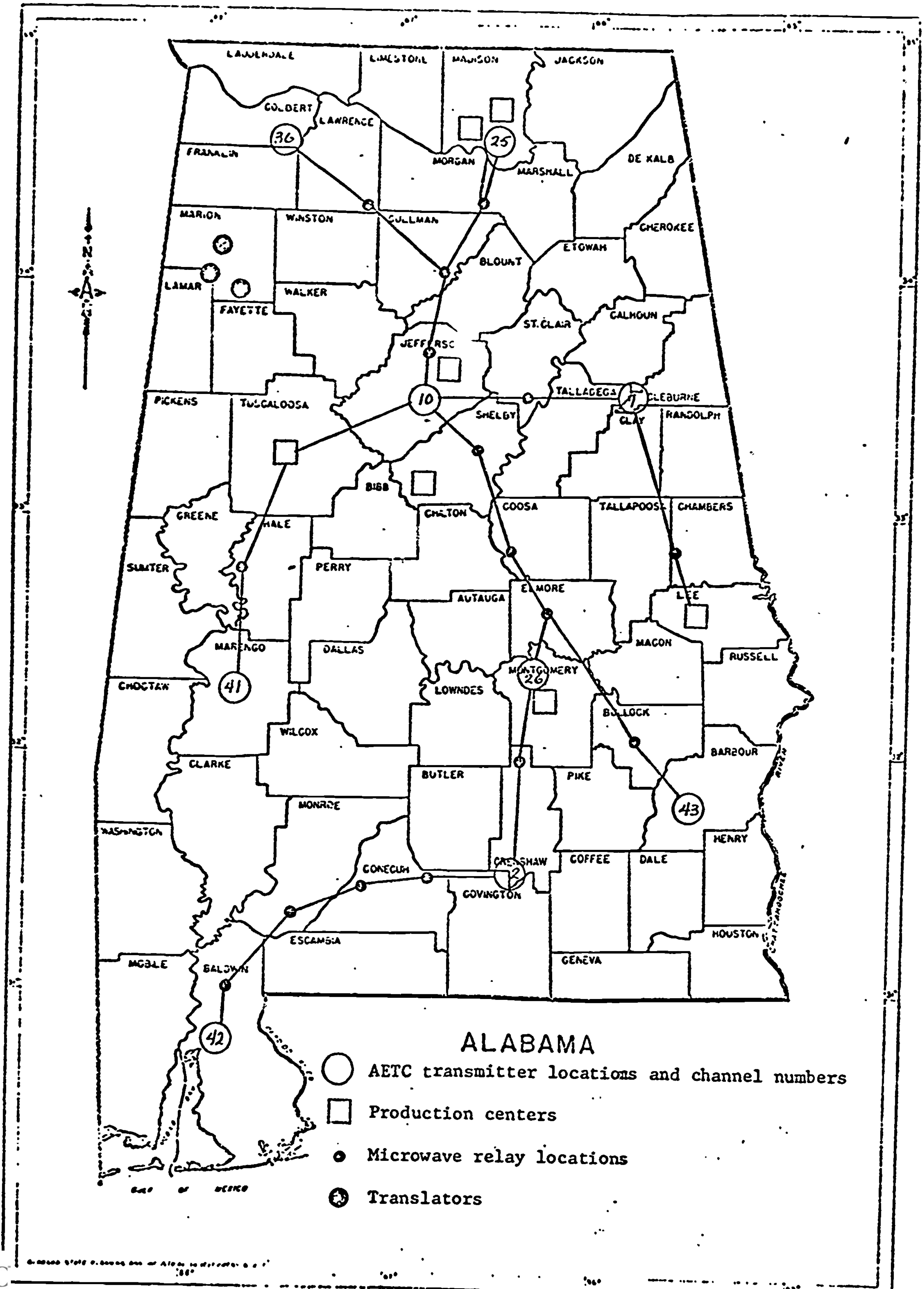

Figure 7.4 CONFIGURATION OF AETN

completing the demonstration.

The main features of the proposed demonstration are given below. The order in which they are listed is not significant. As indicated earlier, the tasks, assignments, and the schedule will be worked out with the various participating agencies after approval to proceed has been received from DHEW.

The main features of the demonstration project:

- Establish a Technical Advisory Committee whose role will be to provide broad guidance and advice on technical matters to the demonstration project task force. Members would be invited from public and private education institutions, elected officials, professional associations, business and industry, and community agencies. Early and continuous participation of local officials is considered essential to continuing local support once the demonstration project is completed.

- Educational television could broadcast programs into the secondary school classrooms. The programs will originate from universities and hospitals. The purpose here is to bring the latest technologies, techniques, and equipment, and the best teaching skills into the rural classrooms. Possible originating points are: (1) Livingstone State University, located in the demonstration area at Livingstone, Sumter County. This school will begin an associate degree program in health occupations beginning with the 1973 school year. (2) The University of Alabama at Tuscaloosa. In addition to health occupation courses, the university is an ETV production center and can serve as a major programming activity. (3) The Research Technical Institute (RTI) located at the Medical Center, University of Alabama at Birmingham. The Institute, which started operations in late 1970, has a responsibility for training allied health specialists. Because it is located at the Medical Center, it has access to the State's most advanced involvement for clinical experience for allied health trainees.

- Telephone links from the classroom to the university and/or hospital where the program is originating could be used in real time for clarification, questions and answers, and general feedback.

- Educational Television could broadcast programs to students and prospective students in their homes. The thought here is that certain parts of the course curriculum would be suitable for broadcast into the homes. The student could attend class, so to speak, in his own home and could interpret what is broadcast to other members of the family or neighborhood. Such subjects as personal hygiene, birth control, and first aid may be ideal for home broadcasts. In addition to student training, other members of the family and neighbors could develop some basic knowledge and skills in health care.

- Educational television and commercial television could be used in a recruitment and selection program. One-minute and 30-second "health occupation commercials" could be scheduled like standard commercial programming. One-hour and 30-minute health occupations programs also could be scheduled. These spots would be used to create an awareness of, and an interest in, health occupations as a job opportunity. They could be used to explain the concept of career education: "It is a people-oriented concept which is responsive to public demand for both relevance and accountability. It is a lifelong process which extends from early childhood through adulthood. Career education is based upon the premise that all honest work and purposeful study is respectable. All types of occupations and all levels of occupational endeavor are contained within its parameters (Ref. 45)".

- Remote ETV units could broadcast programs from local hospitals, local nursing homes, and/or local doctors' examination rooms, showing the health occupation students in on-the-job training or in work-study programs. One of the assumptions of the recently inaugurated Alabama health occupations program in secondary schools is that the shortage of health workers may be due to the fact that health occupations do not have an immediate application to community needs. Getting local students involved in local health care programs and making this known to the community at large could go a long way in recruiting and holding students. This work-study type program supports one of the goals of the Alabama health occupations program which is to present material designed so that the student does not only learn in the traditional academic manner, but also learns vocationally so that he might apply the knowledge directly in health care delivery. (Ref. 46)

- Closed circuit TV and/or cassettes could be used to support the school programs to teach basic skills in reading, writing and simple computations: skills that are essential to success in the health occupations curricula. The program would link the basic skills to the specific health occupations. The need for reinforced basic skills instruction was identified as a major concern by the State Supervisor of Health Occupations Education.

- Spot health occupations commercials would be scheduled on local radio disc jockey programs to reach the secondary school students.

- Use mobile classroom/laboratory with taped instructional programs and equipment to give the students hands-on experience with taking measurements, reading instruments, focusing microscopes, etc.

- Control of the demonstration project would rest with the State Department of Education. The demonstration task force would be composed of persons from the Department of Education, local school systems, AETV, universities, and a not-for-profit research and development corporation.

4. Assessment of Human and Technical Resources

   a. Resources Required

Human resources will include project supervision and coordination; classroom teaching; television and radio script writing, engineering, filming, and production; and participation of personnel from local hospitals, nursing homes, and doctors' offices/clinics.

As a minimum, participation will be invited from the following:

State Department of Education

Alabama Educational Television Commission

Alabama Commission on Higher Education

Local School Systems

University of Alabama in Tuscaloosa

University of Alabama in Birmingham

Regional Technical Institute

Alabama Comprehensive Health Planning Administration

Alabama Regional Medical Program

State Department of Mental Health

Local Elected Officials

Technical resources will include classroom facilities; television monitors, cameras, recorders, and other production equipment to include a remote capability; hospital laboratory equipment; and a mobile classroom/laboratory.

   b. Resources Available

Most of the human resources needed to conduct the demonstration are available in the State. Some rescheduling of staff would be required and some additional staff would have to be hired. The major participating agencies - Division of Vocational-Technical and Higher Education, the Alabama Educational Television Network, the local school districts, and the Regional Technical Institute - are staffed with competent and highly motivated personnel. The one major deficiency is in trained health occupation teachers in the local school systems. But this is , of course, one of the deficiencies that the demonstration project will be designed to overcome through the effective use of telecommunications.

The available technical resources, with the exception of a mobile classroom/laboratory, are considered excellent. The Statewide ETV network includes seven production centers, nine transmitters, three translators, and 2,000 miles of microwave systems. The locations of these facilities are shown in Figure 7.4 and are described in Table VII-4. The equipment in the system includes a remote unit with four cameras and tape-recording capability, portable TV-originating equipment, a remote broadcasting unit under construction that will include color cameras and tape recorders. Educational radio recently has been placed under the same agency that has authority for ETV. The production centers in Tuscaloosa and Birmingham and the transmitter in Demopolis would give principal support to the proposed demonstration project.

5. Assessment of Financial Resources

Some funds possibly could be made available by the State or by the Alabama Regional Medical Program to meet a matching fund requirement. However, most of the state and local contribution would be in-kind service. Some commercial televison and radio time could be made available as a community project. Most of the funds would have to come from the federal government, primarily DHEW. Other Federal agencies who may be interested are the Department of Labor, Department of Commerce, and the Office of Economic Opportunity. The Appalachian Regional Commission is another possible source of funds. Direct contact has not been made with any of these agencies concerning possible funding of this demonstration project.

6. Program Evaluation

The details of an evaluation program would be developed in cooperation with the State Department of Education, local school systems, and the DHEW. The factors to be measured would include such things as number of students seeking information, number of students applying for training, number of students accepted for training, student grades, test scores, and attrition rates. Subjective evaluations of the students and of the student's progress would be

Table VII-4

EDUCATIONAL/PUBLIC BROADCASTING (REF. 47)

Transmitters and Translators

Ch	Call Letters	Location	Power Visual (picture)	Audio (sound)	Antenna above avg. terrain	Height above ground
2	WDIQ	Dozier	100kw	10kw	690'	566'
7	WCIQ	Cheaha State Park	316kw	31.6kw	2000'	574'
10	WBIQ	Birmingham	316w	31.6kw	1050'	795'
25	WHIQ	Huntsville	631kw	126kw	1173'	324'
26	WAIQ	Montgomery	229kw	22.9kw	594'	553'
36	WGIQ	Florence	587kw	58.7kw	760'	538'
42	WEIQ	Mobile	238kw	23.8kw	600'	543'
43	WGIQ	Louisville	675kw	67.5kw	947'	800'
41	WIIQ	Demopolis	447kw	44.7kw	1082'	999'
70	W70AN	Hamilton	Translator			
72	W72AN	Winfield	Translator			
74	W74A	Guin	Translator			

obtained from teachers and from the professional and allied health workers who participate in the work-study and OJT programs.

Ways of measuring the student's attitude towards the techniques and methods used in the demonstration program and his attitude towards a career in a health occupation would be devised.

Periodic assessments would be made of the relative value of the methods and techniques used in the demonstration as the demonstration progressed. The attitudes and opinions of participating supervisors, teachers, students, television and radio personnel, and health workers would be analyzed and appropriate modifications made.

The final evaluation of the demonstration would include a cost analysis and cost comparison with alternative ways of accomplishing the stated objectives.

Program evaluation should be done by an agency other than one of the major participants.

D. General Overview of Needs and Resources

1. Needs in Georgia

High priority needs for which telecommunications may be relevant are presented.

a. Health Care

There is a need to provide better delivery of routine health care to remote areas and provide personal health and hygiene information.

Until recently the rural areas of the United States had a lower mortality rate from chronic diseases such as heart disease, and cancer but have a higher rate from infectious and other currently preventable disease.

Though the mortality rate is almost the same for urban and rural areas the latter has a greater incidence of sickness that limit activities of the population. Table VII-5 gives the statistics by age, sex and income classification. These data show that the rural areas have a greater need for routine health care and information, especially the lower income population.

Medical personnel are also lacking in the rural areas with the supply of M.D.'s only one third that of metropolitan areas, dentists three-fourths that of urban areas, and nurses one-fourth that of the urban areas.

Table VII-5

HEALTH STATISTICS FOR GEORGIA (REF. 48)

% Persons With Limitation of Activities

Area	All	Under 45	45 - 65	65 & over
SMSA's	10.5	4.7	17.1	43.4
Rural Non-farm	14.5	5.7	24.1	56.2
Rural farm	16.5	6.4	27.3	58.9

Restricted Activity Days per 100 Persons

Area	Males		Females	
	1961	1964	1961	1964
Urban	1236	1386	1450	1730
Rural Non-farm	1340	1530	1616	1880
Rural farm	1670	1710	1710	1740

Disability Days per 100 Persons

Income level	Restricted Activity	In-Bed	Work Loss
$7,000 and over	1370	560	550
$4,000 to $6,999	1480	590	590
$2,000 to $3,999	1710	700	730
under $2,000	2280	976	860

Hospitals and other facilities are almost the same for urban and rural areas, with urban areas having 3.8 beds per 1000 population and rural areas 3.6 beds per 1000 population.

Public health facilities are provided in rural areas but at a scale approximately half of that for the most urban areas. Voluntary health insurance, medicare, medicaid, and other government programs have some impact on rural health but distance and availability of personnel and facilities limit the amount of services. The Rural Poverty report also stated that there is a "fatalism" among lower income rural persons that causes them to seek medical attention only in the most serious cases. Table VII-6 shows medical visits.

Table VII-6

MEDICAL AND DENTAL SERVICES 1963-64
(REF. 48)

Visits	SMSA	Rural Non-farm	Rural Farm
M.D.			
Male	4.5	3.7	3.0
Female	5.4	4.8	3.7
Dentist			
Male	1.7	1.0	0.9
Female	2.0	1.4	1.0

b. Government Information Services

Goals for Georgia Surveys indicate the citizens of Georgia have the most confidence in the federal government followed by the state and then local government. In Georgia it was also found that 54 percent had a low level of trust in local government; 58 percent of the people said that they were not getting their money's worth from local government; 39 percent said that local leaders had little concern for problems of the area; and 60 percent felt that they had no impact on the political process. Public uncertainty over their capability to influence government in Georgia is also shown by voter participation. In 1970 the South averaged only 54.2 percent of registered voters voting as compared to 77.7 percent for the U.S.

These figures give a very good indication of the need for better communication between the State and local levels of government and citizens in Georgia. Similar figures can be assumed throughout the Southeast.

In Georgia alone there are approximately 880 separate government bodies comprised of 550 city, 159 county, and other various special districts. The mere numbers show a need for some type of technical information system to enable these governments to be more effective.

In the financial area, as an example, it was found in the local Government Reorganization Study that only 35 percent of these units had any sort of budgeting system and that only 11 could meet the Municipal Financial Officers Association requirements. Other problems encountered at the local level were: incomplete accounting systems, lack of uniformity in accounting procedures, inadequate grant administration and accounting, inadequate capital and fixed expenditure accounting, and little pension or debt accounting.

Thus, in Georgia, the need for assistance and technical information in the financial area alone is great. Adding the requirement for assistance and information in other areas such as solid waste management, pollution control and planning to these numerous governmental units indicates a vast need for technical expertise.

In Georgia there have been several efforts initiated at the state level to find ways to alleviate some of these problems. These include "The Goals for Georgia" program, State government reorganization, reorganization of local governments, hearings by committees of the state legislature concerning community development and planning. At the Federal level, HUD has recently expanded the use of "701" funds to assist local governments in fiscal management.

c. <u>Education</u>

Basic indicators showing needs in these areas are educational level and pre-primary school enrollment. The lower the educational level the greater the need for some type of special or continuing education program. Although the level of education applies to adults 25 and over, it is also an indication of the need for early childhood development, since the early years of education have a great impact on later achievement. Table VII-7 shows that the number of years of schooling is lower in two southern states (selected as examples) than for the U.S. and that the level for blacks is also much less.

Table VII-7

EDUCATIONAL STATISTICS FOR GEORGIA (REF. 49)

Educational Level-Median Years Completed 1960

	U.S.		Georgia		S.C.	
	All	Black	All	Black	All	Black
1960	10.6	8.2	9.0	6.1	8.7	5.9

Pre-Primary School Enrollment - % of Children 3-5 Years of Age

Year	1965	1969	1970
Total	27.1	34.6	37.5
White	27.9	34.8	37.8
Black	23.3	33.5	35.7
Residence			
Central City	29.7	37.3	39.4
Outside Central City	32.5	39.3	43.2
Non-metro areas	19.4	27.7	30.2

The relationship between education and income also shows the need for continuing adult programs. While the 1969 white median family income for college graduates was $14,685 and $9,342 for high school graduates, it was only $6,769 for those with only elementary education. For non-whites the median family incomes were $13,682, $7,875, and $4,754 for the above classifications respectively.

The Federal government has addressed these problem areas through such programs as Model Cities, various welfare programs, and through Manpower development programs. The States, mainly using federal funds, have set up vocational training centers and many are in the process of instituting public kindergartens.

d. Library Services

The need for a variety of data and information is suggested by looking at the volume of requests handled by the Georgia Library Information Network. The center handled 23,407 requests during the 1971-72 academic year from 88 libraries. Of these, 3,165 came from calls over the GLIN WATTS line. This compares with 23,454 total requests, 2,264 which came in over the WATTS line during the previous year.

Georgia has been more organized in centralizing their services than many States. Several states have used grants to establish multiple centers around the State. A few, like Georgia and North Carolina, have centralized their activities and receive and respond to information requests from a single information center.

2. Relevant Resources in Georgia and Adjoining Areas

- Georgia Library Information Network with full Statewide WATT's capability.
- Monroe, Georgia, an established small town, with an operating municipally owned and operated CATV system.
- Grady Memorial Hospital, with inhouse closed circuit TV in operation.
- Peachtree City, a new community of 1400 residents.
- Southern Bell Telephone Communications Center with a wide range of telephone-related modern devices.
- Fernbank Science Center, a special facility for science education augmentation.

- Scientific-Atlanta, Inc., a private (profit) firm with a fully developed and tested two-way digital communications system for use in conjunction with cable.
- Emory University, a well-known educational institution with Computer Aided Instruction in use (e.g., anatomy instruction).
- Model Cities Communication Skills Labs, the Atlanta agency with an installed Hoffman Information System for teaching reading to slower learners (in Smith, Roosevelt, and Parks Junior High).
- A state (Georgia) whose Governor has placed special emphasis on improved health care delivery, pre-school education, and improved government-to-public communications.
- Jacksonville, Florida, a new health clinic linked through closed circuit TV with University Hospital referral clinics ($109,000).

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Appendix A

ITV COST MODELS

A. Introduction

The cost models used to compare alternative delivery systems for ITV are developed in this section. The focus is on the delivery of ITV to schools. There are three major types of costs to be considered:

- Production costs include all personnel and equipment costs required to produce a TV program.
- Distribution costs are those required to build, maintain and operate transmission networks which will deliver a TV program to a given geographic area.
- Reception costs cover the equipment and personnel needed at each school to receive and distribute programs within the school.

Distribution costs are determined for four different types of systems:

- UHF broadcasting.
- ITFS systems serving only the schools involved in the ITV effort.
- Cable systems. Both community-wide and school-owned systems are considered.
- Satellites.

These systems can be used individually or in combination, so the cost models are developed for each type and can be combined as needed in the analysis.

The models presented here are based for the most part on those of General Learning Corporation (Ref.50). In particular, the demographic assumptions made about representative geographic areas have proven to be useful.

B. Demographic Assumptions

The cost models in the General Learning Corporation study were developed for five different demographic environments: local school district, city, metropolitan, state and regional areas. The data regarding each environment are hypothetical but were chosen to be representative of typical cases and are indicated in Table A-1. The average single elementary school enrollment was assumed to be around 600 students and for a single secondary school, 1400. With 14 elementary schools and 4 secondary schools assumed for a typical local district, there are about 15,000 students per district. This compares with an average national value of 3,000 to 4,000 students and reflects the national trend towards unification of smaller local school districts. It is also important to consider large local districts capable of supporting ITV. Where small districts were involved, they would have to cooperate to share costs. The state is not assumed to contain the large metropolitan area discussed and hence has a lower population than would be expected if it did. Numbers of students for each category have been rounded off for convenience and therefore are not in constant proportion to population.

C. Planning, Administration, and Research and Evaluation

Before determining cost estimates directly for production, distribution and reception, costs will be determined for initial planning, administration, and research and evaluation. They can be allocated to production, distribution and reception on a 30%, 40%, 30% basis.

1. Initial Planning

The estimates for initial planning costs are somewhat arbitrary and the values given in Table A-2 are considered to be representative. The initial planning costs provide manpower for the selection of manufacturers and vendors, an assessment of community communication needs and design of specifications for the resulting system.

2. Administration

The administrative diagram in Figure A.1 is used to estimate the cost for this category given in Table A-3. In the smaller applications, such as local and city, the role of some administrators may combine some responsibilities.

3. Research and Evaluation

This cost component refers to research and evaluation efforts outside the scope of usual administrative control and feedback functions included under general administration. The testing of students is used to evaluate program

Table A-1

DEMOGRAPHIC MODELS

Demographic Unit	Population	Area Sq. Mi.	Radius Coverage in miles	Number of Elementary Schools	Number of Secondary Schools	Number of Students
Local District	-	irregular shape	6	14	4	15,000
City	800,000	70	6	136	46	150,000
Metropolitan	2,000,000	1,500	30	546	183	600,000
State	4,500,000	40,000	-	920	310	1,000,000
Region	42,000,000	550,000	-	9,200	3,100	10,000,000

Table A-2

INITIAL PLANNING COST

Local

Manpower		
Project Leader	1 manyr. @ 14,000	$14,000
Technical and Legal	1/4 manyr. @ 18,000	4,500
Technical	3/4 manyr. @ 12,000	9,000
Educator	1/2 manyr. @ 12,000	6,000
		$33,500
85% Overhead		27,500
TOTAL		$64,000

City

Manpower		
Project Leader	1 manyr. @ 14,000	$14,000
Technical and Legal	1/4 manyr. @ 18,000	4,500
Technical	1-1/2 manyr. @ 12,000	18,000
Educator	1 manyr. @ 12,000	12,000
		$48,500
85% Overhead		41,200
TOTAL		$89,700

Metro

Manpower		
Project Leader	1 manyr. @ 14,000	$14,000
Technical and Legal	1/4 manyr. @ 18,000	4,500
Technical	2 manyr. @ 12,00	24,000
Educator	1 manyr. @ 12,000	12,000
		$54,500
85% Overhead		46,300
TOTAL		$100,800

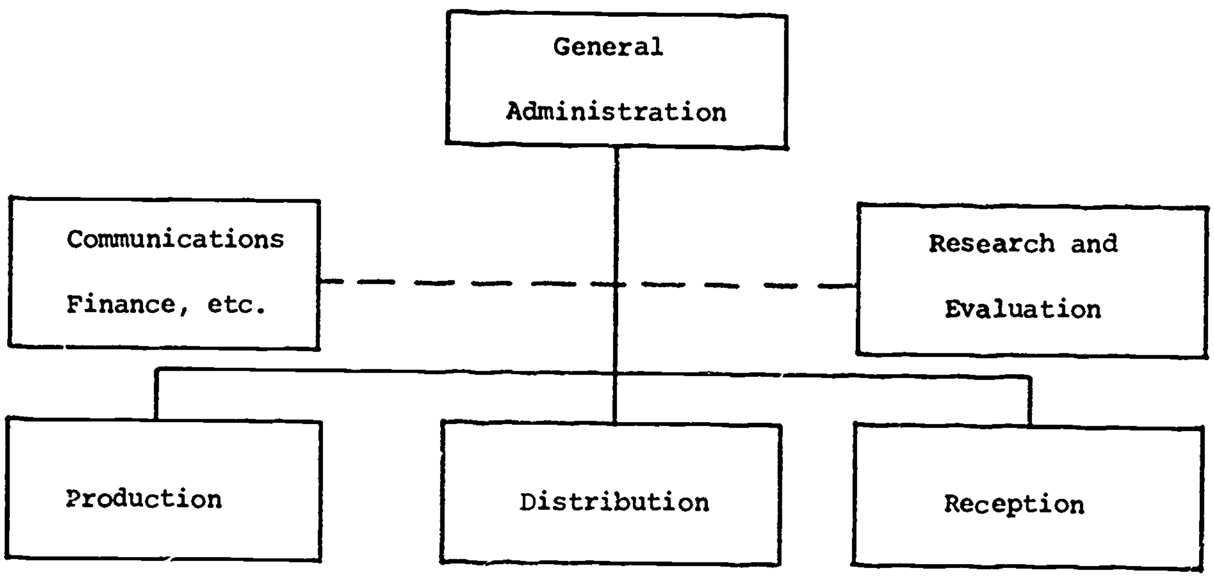
Table A-2
(continued)

State

Manpower		
Project Leader	1-1/2 manyr. @ 18,000	$ 27,000
Technical and Legal	1/2 manyr. @ 18,000	9,000
Technical	4 manyr. @ 12,000	48,000
Educator	2 manyr. @ 15,000	30,000
		$114,000
85% Overhead		97,000
Travel		15,000
TOTAL		$226,000

Region

Manpower		
Project Leader	1-1/2 manyr. @ 20,000	$30,000
Project Assistant Director	1-1/2 manyr. @ 15,000	22,500
Technical and Legal	5 manyr. @ 18,000	90,000
Technical	20 manyr. @ 12,000	240,000
Educator	10 manyr. @ 15,000	150,000
		$532,500
85% Overhead		452,000
Travel		25,000
TOTAL		$1,009,500



ORGANIZATION FLOWCHART

Figure A-1

Table A-3

ADMINISTRATIVE COSTS

	Local	
Manpower		
Director	12,000	$12,000
Assistant	9,000	9,000
		$21,000
20% Overhead		4,200
TOTAL		$25,200
	City*	
Manpower		
Director	12,000	$12,000
Assistants (3)	9,000	27,000
		$39,000
20% Overhead		7,300
TOTAL		$46,800
	Metro	
Manpower		
Director	15,000	$15,000
Associate Director	12,000	12,000
Assistants (4)	9,000	36,000
		$63,000
20% Overhead		12,600
TOTAL		$75,600

* Based on Hagerstown, Maryland as example.

Table A-3
(continued)

State

Manpower		
Director	20,000	$20,000
Assistant	15,000	15,000
		$35,000
20% Overhead		7,000
TOTAL		$42,000
		plus local, city and metropolitan as required

Regional

Manpower		
Regional Director	25,000	$25,000
Assistant	20,000	20,000
		$45,000
20% Overhead		9,000
TOTAL		$54,000
		plus administrative for ten states

effectiveness on a continuing basis and yearly reports are made by a separate research and evaluation staff based on test results and administrative analysis. Research and evaluation cost are estimated at $50,000 for two full time specialists plus an additional 10¢ for testing each student.

D. Production Costs

Production costs are dependent on the quality of the program being created. Costs for an hour of TV production can range from $100 to $100,000 or more depending on the number of people in the program, the use of sets and any special effects.

The General Learning Corporation investigated four approaches for obtaining estimates:

- Statistical measures of actual costs
- Expert opinion of the cost of "good" quality materials
- Minimum costs of educational material
- Maximum costs for innovative materials which would make full use of the media's potential.

The statistical measures of actual costs approach was abandoned because of undependable accuracy in the data which gave suspiciously low values. For example, many cost figures they felt did not include teacner's time in the production, etc. The expert opinion of the cost of "good" quality materials approach set up a hypothetical studio and yielded production costs of $6,000/hr. These "good" and "minimum" quality cost cases due to General Learning Corporation are costed out in Tables A-4 and A-5. The maximum costs effort was placed in a range of $90,000 to 600,000/hr. based on a brief survey of commercial rates.

In costing out operations of various sizes in which school districts cooperate together to share programming costs, we obviously expect to see some increase in the production costs spent collectively per hour of programming. Another trend pointed out in the GLC report as areas are aggrega[illegible] is that increased need for diversity in courses for students will result in more programming hours being produced in these larger collective efforts. Discussion also centered on determining the time to obsolescence of programming which

Table A-4

GOOD QUALITY EDUCATIONAL PROGRAMMING EFFORT
FOR 75 TWENTY MINUTE LESSONS
(REF. 50)

Teacher (annual salary plus moving expenses)	$ 14,000
Content Specialist (annual salary plus moving expenses)	$ 11,000
Guide Writer 1/2 time	$ 4,500
Measurement & Learning Research Specialist 1/2 time	$ 7,500
Pretesting Expenses	$ 2,500
Course Outline Advisory Committee (6 people, 10 days expenses)	$ 9,000
Reviewers (2 @ $10/lesson)	$ 1,500
Studio Production (75 @ $1,000 each)	$ 75,000
	$125,000
Overhead (@ 20%)	25,000
	$150,000

The $1,000 per lesson cost for studio production is derived as follows, assuming five series can share one studio.

STUDIO OPERATING COST

1 Producer-Director 1/2 time	$ 6,000
4 State, light and camera men 1/5 time	$ 6,000
2 Engineers 1/5 time	$ 3,000
1 Artist 1/5 time	$ 2,000
1 Stage manager 1/5 time	$ 2,000
Heat, light, power 1/5 time	$ 2,500
Video Tape for 75 lessons 2", 15IPS, boxes	$ 7,000
Props, talent and incidentals @ $150 per lesson	$ 11,500
I. O. Tubes	$ 1,000
Amortization on $300,000 capital 1/5 (20 years on studio, 5 years on equipment)	$ 9,000
	$ 50,000
Overhead at 50% (studio operations have high overhead)	25,000
	$ 75,000

Amortization is on capital equipment assumed as follows:

STUDIO CAPITAL COST

Studio control, switching and distribution	$ 15,000
VTR and accessories	$ 50,000
3 I.O. cameras, pedestals, and cable	$ 75,000
Test and miscellaneous equipment	$ 16,000
Studio, control room, and auxiliary construction 4,500 sq. feet @ $32/sq. ft. (NAB Handbook)	$144,000
	$300,000

Table A-5

MINIMUM QUALITY PROGRAMMING EFFORT FOR 60 HOURS OF PROGRAMMING A YEAR

(REF. 50)

Teacher annual rate	$ 8,000	
Materials at $10/lesson	1,800	
1 Set	200	
Producer-Director 1/5 of $10,000	2,000	
2 Cameramen 1/5 of $3,000	600	
1 Engineer 1/5 of $10,000	2,000	
Utilities 1/5 of $2,000	400	
Overhead	2,000	
Depreciation on $30,000 equipment*	1,000	
	$18,000 / 60	= $300/hour

* Depreciation based on 1/5 year usage of 6 year life of $30,000 facility as shown below.

STUDIO CAPITAL COST

Studio 40'x20'=800 sq.ft. @ $20/sq.ft.	$16,000
2 vidicon cameras	4,000
Lighting	1,500
Air-conditioning	2,500
Switching, control and wiring	6,000
	$30,000

is estimated at from three to seven years for annualizing these costs. For the purpose of estimating these factors in the GLC study, the programming models indicated in Table A-6 were used.

E. Distribution

Distribution costs are those for constructing and operating the system to deliver the video programming to each school building. The types of transmission facilities considered include instructional television fixed service (ITFS), UHF Broadcast, cable and satellite. Where necessary to build up an interconnected system, the charges for microwave interconnections and, alternatively, satellite interconnection are presented separately. These models are developed with the idea of providing for interchanging various local and regional connection schemes and obtaining the cost changes. For example, local cable systems may be interconnected by terrestrial microwave links or satellite.

In addition, facilities which enhance the useability of the system can be added in various configurations and the associated cost changes easily estimated. For example, the addition of local videotape libraries at each school building could provide desired flexibility. Cost formulas given enable a rapid estimate of the cost of such facilities. These library cost results can then be weighed against the operational flexibility gained.

1. UHF Broadcast

The UHF Broadcast distribution facility would be received by the general public in its area of coverage as well as school buildings or other special reception points. The basic cost components are the capital and operating costs for the transmitter, tower and associated building requirements. Additional costs for interconnecting stations with microwave links or providing studios at each UHF broadcast station can be added using cost estimates for these facilities given under Additional Costs.

a. Capital Cost

The basic capital cost formula for a single UHF broadcast station

Table A-6

POSSIBLE PRODUCTION COSTS

Application Area	Hours (1)	% Rent	Cost/Hour (2)	Sub. Total	%Produce	Cost/Hour	Sub. Total	Total
Local	1000	1/2	$145	$72,500	1/2	$ 300 (3)	$ 150,000	$ 222,500
City	1200	1/4	145	43,500	3/4	400 (3)	360,000	403,500
Metropolitan	1300	1/4	145	47,125	3/4	5,000 (4)	4,875,000	4,922,125
State	1500	1/4	145	54,375	3/4	5,000 (4)	5,625,000	5,697,375
Region	1600	1/4	145	58,000	3/4	5,000 (4)	6,000,000	6,058,000

Production Assumptions:

(1) 1/2 of total hours are 20 min. tapes, 1/2 are 30 min. tapes; 1000 hours = 2500 tapes (1500 20 min. tapes + 1000 30 min. tapes)
(2) Cost estimate from National Programming Source.
(3) Minimum quality estimate.
(4) High quality programming are estimated as follows:
- Cost of 20 min. tapes at $100 per min.
- Cost of 30 min. tapes at $66.67 per min. assuming most costs are fixed.
- Cost per hour = 30 X $100 + 30 X $66.67 = $5,000 per hour.

is given by

$$\text{UHF Capital Cost} = X_o N + T_o + B_o$$

where,

X_o = basic transmitter and antenna cost

N = number of channels

T_o = tower cost

B_o = building and miscellaneous equipment cost

The individual cost terms are estimated as follows:

- Transmitter and Antenna Cost. The cost for a 2kW UHF transmitter and antenna as probably required for local and city application is $82,500. For metropolitan, state and regional applications, more powerful 10kW transmitters would probably be used and joined in the state and region by some microwave interconnection network. The cost of a 10kW transmitter and antenna is around $170,000. The interconnection cost will be considered separately below. (Table A-7)

- Tower Cost. The tower used to support the broadcast antennas has a cost which may be assumed to vary proportionally with height. The tower also varies with the number of antennas which it supports for multichannel broadcasting. This cost variation with number of antennas is primarily due to increased structural support to offset increased wind loading. The resulting tower costs per foot including the transmission line to the antenna are given in Table A-8.

  Typical tower heights for each area of coverage are shown in Table A-9. A useful rule of thumb formula for the radius of coverage on level ground as a function of antenna height is given by

  $$(\text{RADIUS in miles}) = \sqrt{2 * (\text{HEIGHT in Ft.})}.$$

- Remaining Broadcast Station Capital Cost, B_o. The remaining station capital costs are expressed by the equation given in Table A-10.

- UHF Broadcast Operating Costs. The broadcast costs presented in Ref. 50 with updated manpower salaries are given in Table A-11.

Table A-7

TRANSMITTER AND ANTENNA COST, X_o (REF. 50)

Probable Application	Power average station	Cost per average station	Number of stations
Local	2kW	$ 82,500	1
City	2kW	82,500	1
Metropolitan	10kW	170,000	1
State*	(avg) 9.2kW	153,800	20
Region*	(avg) 9.2kW	153,800	154

*Average values computed from results for typical state having two 2kW and eighteen 10kW transmitters.

Table A-8

COMPLETE TOWER COSTS (REF. 50)

Costs per linear foot in height	No. of Channels
$138/lin. ft.	one
$194/lin. ft.	two
$288/lin. ft.	four

Table A-9

TYPICAL TOWER HEIGHTS (REF. 50)

Descriptor	Approx. Radius of coverage	Height	Number of stations required	Interconnected Distance
Local	20 mi.	300 ft.	1	N.A.**
City	30 mi.	500 ft.	1	N.A.
Metropolitan	40 mi.	800 ft.	1	N.A.
State*	25 mi.	350 ft. (avg)	20	675 mi.
Region*	25 mi.	350 ft. (avg)	154	9240 mi.

*Computed from tower mix for a specific state coverage of ten 100 ft., two 500 ft. and six 700 ft. towers.

**Not Applicable

Table A-10

REMAINING BROADCAST STATION COST, B_o (REF. 50)

$$B_o = \underbrace{\$1{,}300}_{\substack{\text{RF load}\\ \text{\& Wattmeter}}} + \underbrace{\$7{,}800}_{\substack{\text{Test}\\ \text{equip.}}} + (\underbrace{\$7{,}000}_{\substack{\text{Control}\\ \text{console}}} + \underbrace{\$18{,}000}_{\substack{\text{Input \&}\\ \text{Monitoring}\\ \text{quip.}}})N + \underbrace{\begin{Bmatrix} 8{,}000 \\ 14{,}000 \\ 20{,}000 \end{Bmatrix}}_{\substack{\text{Spare tube}\\ \text{set}}} + \underbrace{\begin{Bmatrix} 31{,}600 \\ 51{,}200 \\ 83{,}500 \end{Bmatrix}}_{\substack{\text{Bldg., site}\\ \text{dev. and land}}}$$

$$+ \underbrace{\begin{Bmatrix} 30{,}000 \\ 40{,}000 \\ 50{,}000 \end{Bmatrix}}_{\substack{\text{Installation,}\\ \text{etc.}}} \text{ for } \underbrace{\begin{Bmatrix} \text{one} \\ \text{two} \\ \text{four} \end{Bmatrix}}_{\text{Channels}}$$

where N = number of channels

Table A-11

BROADCAST STATION ANNUAL OPERATION COSTS (REF. 50)

ITEM	One Channel	Two Channels	Four Channels
Engineers	$10,000	$10,000	$20,000
Technicians	8,000	16,000	16,000
Power, tubes & repair parts	10,000	20,000	40,000
Building maintenance & utilities	1,800	2,700	4,000
Tower maintenance & utilities	2,000	2,000	2,000
Insurance	3,700	6,300	11,000
Total for one Broadcast Station	$35,500	$57,000	$93,000

2. Instructional Television Fixed Service

Instructional television fixed service refers to a broadcast educational facility in the 2500 to 2690 MHZ range. Current regulations effectively limit the number of channels available to a single user to a maximum of four and transmitter powers to around 10 watts. The result of this low transmission power is an effective range on the order of 10 to 20 miles. The frequency range specified is above the VHF and UHF television receiver channels and, therefore, special converters are required to receive these signals thus making it unavailable to the general public. The tower and transmitter specifications for ITFS systems are more standard than for UHF Broadcast facilities and hence we may assume a 10 watt transmitter with a 200 foot tower. The capital and operating cost formula for typical stations are given in Table A-12. The number of stations which may be expected for various areas of coverage is given in Table A-13.

3. Cable Television

The use of cable television for the local distribution of instructional television may utilize one of two forms: community antenna television (CATV) or closed circuit television (CCTV). The CATV systems presently being developed distribute commercial television to an entire community and in that way provide public viewing. The CCTV, on the other hand, is a private system only distributing among a specified user group, for example, the school buildings in a local district.

a. CCTV Costs

Annual cost estimates per mile for CCTV as quoted by the Chesapeake and Potomac Telephone Company are indicated in Table A-14.

b. CATV Costs

CATV refers to a community wide cable television system. These facilities have the feature of reaching a wide audience and hence have a broadcast type of audience potential. If we consider using these facilities for distribution among schools we are in some sense underutilizing these facilities since the capital investment provides for reaching the whole community. The following simple argument gives strong evidence that a closed

Table A-12

ITFS STATION COSTS
(REF. 50)

$$\text{CAPITAL COST} = \underbrace{12{,}000N}_{\text{10 Watt transmitter}} + \underbrace{10{,}000}_{\text{200' tower}} + \underbrace{3{,}500}_{\text{antenna}} + \underbrace{1{,}500}_{\text{wave guide to antenna}} + \underbrace{6{,}000}_{\text{test equipment}}$$

$$+ \underbrace{\left\{\begin{matrix} 20{,}000 \\ 20{,}000 \\ 24{,}000 \end{matrix}\right.}_{\text{Bldg. \& land}} + \underbrace{\left\{\begin{matrix} 3{,}000 \\ 4{,}000 \\ 5{,}000 \end{matrix}\right.}_{\text{Installation}} \quad \text{for} \left\{\begin{matrix} \text{one channel} \\ \text{two channels} \\ \text{four channels} \end{matrix}\right.$$

$$= \left\{\begin{matrix} 56{,}000 \\ 69{,}000 \\ 98{,}000 \end{matrix}\right. \quad \text{for} \left\{\begin{matrix} \text{one channel} \\ \text{two channels} \\ \text{four channels} \end{matrix}\right.$$

where N is the number of channels.

$$\text{OPERATING COST} = \underbrace{8{,}000}_{\text{2nd class operator}} + \underbrace{\left\{\begin{matrix} 2{,}800 \\ 3{,}400 \\ 5{,}000 \end{matrix}\right.}_{\text{ITFS supplies parts and insurance}} = \left\{\begin{matrix} 10{,}800 \\ 11{,}400 \\ 13{,}000 \end{matrix}\right.$$

Table A-13

ITFS STATION REQUIREMENTS

Coverage	Number of Stations
Local	1
City	1
Metropolitan	5
State	130
Region*	1300*

*Estimated from General Learning Corporation results using state estimate.

Table A-14

ANNUAL CCTV COSTS OBTAINED FROM THE CHESAPEAKE AND POTOMAC TELEPHONE COMPANY

	One Channel	Two Channel	Four Channel
Local cable costs /mile	$750	$960	$1,248

circuit system should be purchased separately for such applications involving video distribution among members of a school system.

Suppose that there are N_H households in the CATV system in a community of size A square miles containing N_S schools. From the interconnection equation A.10 derived later by assuming a uniform equilateral distribution, we have the number of miles of interconnection per square mile for the CATV system among households (M_H) as,

$$\text{CATV:} \quad M_H = 1.07\left(\frac{N_H}{A}\right)^{1/2}$$

and the close circuit mileage per square mile among schools (M_S) as,

$$\text{CCTV:} \quad M_S = 1.07\left(\frac{N_S}{A}\right)^{1/2}$$

The total cost for each system assuming an average cable cost per mile of C_o is,

$$\text{CATV:} \quad C_H = 1.07(N_H A)^{1/2} \, C_o$$

and

$$\text{CCTV:} \quad C_S = 1.07(N_S A)^{1/2} \, C_o.$$

Assuming a twenty-four channel capacity on the CATV system and zero cost interconnection to the schools, we can determine the resource sharing cost to the schools C_{HS} assuming they use four channels exclusively as,

$$C_{HS} = (4 \text{ channels}/24 \text{ channels}) \, C_H$$

$$= C_H / 6.$$

The CCTV system is preferred to using the community-wide CATV system when:

$$C_S < C_H / 6$$

or

$$N_S < N_H / 36.$$

Since the number of households per school (N_H/N_S) is several orders of magnitude greater than 36 in practice, we suspect that the CCTV system would be favored in general over the CATV use from a cost point of view. However, determining actual CATV charges to educational systems will be complicated in practice since many CATV operators have unused channels and are willing to subsidize educational use to achieve community goodwill. In order to prorate the system cost attributed to educational users, we must consider full channel utilization by other users including commercial interests. For such CATV cost estimates, the cost we are interested in determining is an estimate of the average cost per channel hour based on use. The following cost discussion based on Reference 51 derives such cost estimates for a cable system.

As indicated by the cost expression for C_H, we would expect the cable system cost to depend strongly on the density of homes. For typical urban locations with medium to high density, about 500,000 homes can be served by 100 miles of trunk cable. Using $15,000 per mile as the cost of underground trunk cables, taking $45 per subscriber for the line for the trunk cable to the house (house-drops), and allowing $50,000 for head-end buildings, antennas and related costs, we have a cost for a 10,000 subscriber system with 50 percent market penetration of $110 per subscriber. These costs are for typical underground systems and are based on information from the National Cable Television Association as reported by Comanor and Mitchell in Ref. 52. Although the $15,000 per mile for the cable represents the current national average costs, in some metropolitan areas these costs may run $50,000 or more per mile. At this higher cable rate of $50,000 per mile, the resulting capital cost per subscriber is $250. To estimate a total monthly cost for the cable, the capital cost can be annualized using an interest rate of 8 percent per year over a 10 year lifetime and a maintenance cost can be included of 10 percent of the capital cost per year to obtain a monthly cost equal to 1/48 the capital cost. Therefore, the monthly cost corresponding to the capital cost of $110 per subscriber is $2.29 per month per subs·riber. Assuming 400 hours per month of transmission per channel on a 24 channel system, we obtain an average cost per channel hour · * $2.38.

4. Satellite Television System

Since the number of possible satellite system configurations is large, we consider a range of representative values of satellite costs based on contact with experts in the area and upon Ref. 53. Table A-15, taken from Ref. 53 is also useful in estimating these costs by presenting some cost estimates by various companies intending to launch satellites. The basic cost components are the satellite and launch cost, receive and transmit ground stations and receive only ground stations.

The satellite data presented in the General Learning Corporation study were generated by General Electric Missiles and Space Division. The cost figures were $21,500,000 for development and $18,300,000 for hardware and launch. Amortizing the developmental cost over 10 years at 5% and the hardware and launch costs over a more realistic lifetime of 7 years rather than 2 years as done in the GRL report, we obtain a yearly channel cost of $1,480,000. This cost is still realistic in terms of the current cost ranges and reflects the longer lifetimes currently observed in operational satellites.

The receive only g[illegible] costs used by General Learning Corporation seem realistic at $1,0[illegible], if a relatively high power signal is transmitted from the satelli[illegible] as[illegible]sumed here. However, the master transmit-receive ground station costs of $20,500,000 appear to be an order of magnitude too high and a cost of around $1,000,000 would appear more realistic. Satellite costs ranges felt to be realistic for the design configurations considered here are summarized in Table A-16.

5. Special Distribution Costs

In addition to the basic distribution costs considered, we have special costs which may be added to improve distribution and provide additional flexibility. In the case of community facilities like cable television, ITFS and

Table A-15

SATELLITE ATTRIBUTES AND COST (REF. 53)

Satellite	Weight (lbs.) In-orbit	Weight (lbs.) pad	Launch Vehicle	Total RF Power	Frequency Bands[4]	Satellite Supplier[6]	Number of Transponders	Transponder Bandwidth (MHz)[7]	Total Bandwidth (MHz)[7]	Prime Power (D.C. watts)	Design life (years)	Contemporary ?	Investment Cost ($ M): Launch Costs[8] First	Launch Costs[8] Subsequent	Satellite Costs First	Satellite Costs Subsequent	Development Costs	TT&C Costs[9]	Total Investment[12] for one in-orbit satellite ($ M): Total	Per Unit
INTELSAT I	85	150	Thrust-Augmented Delta	-	C	Hughes	2	(13)	50	-	1.5		3.3	3.3	[illegible]	3.6	n.a.	-	10.7	-
II	165	357	Thrust-Augmented Delta	18	C	Hughes	1	130	130	-	3		3.6	3.3	4.1	3.5	n.a.	-	7.6	.413
III	325	647	Thrust-Augmented Delta	20	C	TRW	2	225	450	-	5		3.1	3.1	4.0	4.3	n.a.	-	9.1	.455
RS-333: TELSAT	510	1204	Thor Delta	33[10]								✓			8	8	Included	-	13.0	.360
TELSAT - Alaska	510	1204	MDT	33[10]	{C}	{Hughes}	{12}	{35}	{432}	{210}	{7}	✓	{7}	{7}	8	8	2	-	17.0	.343
Hughes (D)	453	1120	Thor Delta MDT	60								✓			8[10]	8[10]	{Included}		13.0	.315
Western Union (D)	510	-	Thor Delta MDT	60								✓			6[11]	5[11]			13.0	.315
RS-338	548	1560	Thor Delta Upgrade	96	S	Hughes	-	-	100	-	~10	✓	7	7	6.3	(6.3)	(8.4)	(.9)	31.7	.247
RCA (D)[3]	638	1412	Thor Delta 904	80	C	RCA	12	36	432	~305	7	✓	7.3	7.3	3.6	3.6	14.8	1.3	25.7	.132
MCI (D)	663	46	Thor Delta 2914	60	C,K	N.A.R.	12	36	432	-	7	✓	7.5	7.5	6	2	15	.5	31.5	.473
ATS - 1	775	-	Atlas Agena D	16	{C}	{Hughes}	{2}	3	25	30	-									
- 3	796	-	Atlas Agena D	32				2	25	30	-						n.a.			
INTELSAT IV	1225	3058	Atlas Centaur	120	C	Hughes	12	36	432	-	7	✓	16.	16	23	10	(0)	-	37.0	.509
COMSAT (D)	1550	3100	Atlas Centaur	85	C	-	24	36	816	~740	7.75	✓	17.0	17.5	13.6	13.5	13	3.7	45.3	.309
ATS - F[6]	~1500	3500	Titan IIIC	15	VHF,C		-	-	-	-	2.5	✓					n.a.			
- G[6]	-	-	-	~200		F-H	-	-	-	750	7		23.7	23.7	14.7	14.7	16.			
Fairchild-Hiller (D)[6]	~2600	2903	Titan IIIC Uprate	55	S,C,X[5]	F-H	120	35	-	750	7	✓	23.7	23.7	14.7	14.7	19.6	8.3	57.0	.6
MCI - Lockheed (D)[6]	2500	-	Titan IIID Agena	672	C,K	Lockheed	43	36	1728	4400	10	✓	22.5	21	20.8	20.8	20.2	1.8	71.6	.09

NOTES:
- n.a. = not applicable
- \- = unknown
- (D) = Domestic filings
- 1 = 3-axis stabilized
- 2 = Spin-stabilized option (similar to RS-333)
- 3 = Approximate; some weights apply after apogee motor fire and are higher than final in-orbit weights
- 5 = End-of-life total RF power
- [illegible] = V = VHF; S = 2.5 GHz; C = 4/6 GHz; X = 12 GHz; [illegible]; m = millimeter
- 4 = 7/13 GHz used instead of 12/13 GHz
- 6 = F-H is Fairchild Hiller; N.A.R. is North American Rockwell
- 7 = [illegible] (~1 GHz) bandwidth
- 8 = Includes range support
- ( ) = approximate (estimated)
- 9 = For two or more active satellites
- 10 = Assumed to be the same as Western Union
- 11 = Western Union will pay a [illegible] for 3 satellites and 3 launches, or about $[illegible] [illegible] satellites, including development and TT&C costs.
- 12 = Includes development costs [illegible] TT&C costs.

Table A-15

TYPICAL RANGE OF COSTS FOR SATELLITES 1972

Satellite Channel Cost	
$1,000,000 - $2,000,000	per channel year based on 15 watt per channel satellite of $25,000,000 - $50,000,000 amortized at 5% over a 7 year lifetime.
$1,480,000	per channel year for 17 watt per channel satellite priced in the General Learning Corporation study.

Ground Station Cost	
$1,000 - $2,500	for a receive only with 10 foot parabolic dish antenna.
$500,000 - $2,000,000	for a send and receive master station

UHF broadcast, we need to consider methods for interconnecting the basic facilities using microwave links. The satellite system by its nature already provided for regional distribution from some central production facility to each reception point over a regional area. In the case of systems like cable television, ITFS and UHF, we also might want to provide for local tape libraries and facilities for taping regional programming for possible later replay. Another additional local facility might be a studio facility for local programming, the costs of which are given in Table A-4 and A-5. The cost models in this section provide cost estimates for the system interconnection and replay features which can be added to distribution costs. In this way initial total system costs for planning purposes may be obtained.

a. Interconnection System Costs

Schemes for interconnecting cable television, ITFS or UHF broadcast community systems using terrestrial microwave links or satellite distribution will now be discussed. After developing the costs per mile for terrestrial systems, formulas for estimating these interconnection distances as a function of area and number of points to be connected are developed.

1. Microwave Interconnection Costs. The costs for a microwave relay station as estimated in Ref. 50 are presented in Table A-17. The average distance between microwave stations is usually 30 miles allowing us to express this in terms of capital cost per mile of network. The annual operating costs are based on several companies' experiences. These tables also present the reduction in cost when the microwave relay station occupies the same facilities (tower, building, etc.) with ITFS or UHF systems. This would be the case when the microwave links terminate on these ITFS or UHF facilities.

If we amortize the microwave capital cost per mile as presented in Table A-17, at 5% over 10 years by multiplying by the resulting .129 discount factor and add operating cost, we obtain the results given in Table A-18. For comparative purposes, the Chesapeake and Potomac phone company costs for microwave service is also indicated in Table A-18.

2. Terrestrial Interconnection Distance Model. In applying the microwave interconnection costs to a given configuration, we must lay out the

Table A-17

MICROWAVE RELAY STATION COSTS (REF. 50)

Part I. Capital Costs

ITEM	ONE CHANNEL	TWO CHANNELS	FOUR CHANNELS
Television relay equipment fault alarm & audio channel	$15,000	$25,000	$45,000
Antennas	3,000	3,000	3,000
Wave guides	2,000	2,000	2,000
Battery power	1,000	2,000	4,000
Building	2,000	3,000	4,000
Tower	24,000	24,000	24,000
Site improvement	3,000	3,000	3,000
Land	2,000	2,000	2,000
Multiplex-filters	0	1,000	1,500
TOTAL FOR ONE RELAY STATION	$52,000	$65,000	$88,500
CAPITAL COST PER MILE OF NETWORK	$ 1,733	$ 2,177	$ 2,950
Adjustment for tower, site improvement, building & land when located with existing ITFS or UHF facilities.	($31,000)	($32,000)	(33,000)

Part II. Annual Operating Costs Per Mile of Network

ITEM	ONE CHANNEL	TWO CHANNELS	FOUR CHANNELS
Technicians and travel	$ 45	$ 50	$ 60
Power	20	30	50
Parts and repair	35	45	65
TOTAL	$100	$125	$175

Table A-18

MICROWAVE ANNUAL CHARGES PER MILE (REF. 50)

Source	One Channel	Two Channels	Four Channels
Table A-17	$324	$406	$555
Chesapeake & Potomac Phone Co. Rates	$330	$480	$750

interconnections in the detail required in each application. For the present, we would like to present an interconnection model from the GLC study which may be used for a rule-of-thumb estimate based on the number of distribution points (N) and geographic area of coverage (A). Assume the points are distributed in an equilateral triangular lattice as shown in Figure A.2. We want to determine the minimum connecting mileage on a per square mile basis, m.

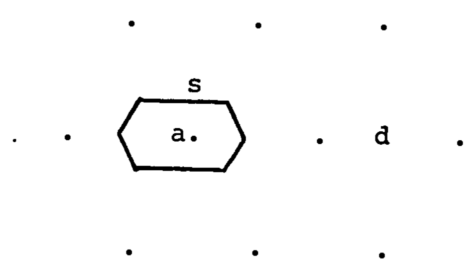


Figure A.2 ILLUSTRATION OF HOMOGENEOUS EQUILATERAL TRIANGLE DISTRIBUTION

Let a = area served by each local distribution point

s = length of a side of hexagonal area served by local distribution point

n = minimum number of links connecting N distribution points in a line

d = nearest neighbor distance, a crystallographic term for the nearest points in the lattice.

The length of the connecting line will be minimal if both the number of linkages and the distance between points linked in the lattice are minimal. Then it must be true that since d is the shortest linkage possible

$$m = \frac{nd}{A} \quad \text{(A.1)}$$

The minimum connecting linkage of N points is

$$n = N - 1 \quad \text{(A.2)}$$

and for an area as large as a state

$$n = N \quad \text{(A.3)}$$

approximately.

For a hexagon,

$$a = 2.6S^2 \quad \text{(A.4)}$$

and solving for s yields,

$$S = .62(a)^{1/2}. \quad \text{(A.5)}$$

Also,

$$d = 2s\ (\sin 60^{\circ}) = 1.73s \quad \text{(A.6)}$$

and on the average,

$$a = \frac{A}{N}. \quad \text{(A.7)}$$

Substituting A.5 and then A.7 into A.6 gives,

$$d = 1.07\ \left(\frac{A}{N}\right)^{1/2} \quad \text{(A.8)}$$

and substituting A.3 and A.8 into A.1 yields,

$$m = \frac{1.07N\ (A)^{1/2}}{(N)^{1/2}\ A} \quad \text{(A.9)}$$

$$m = 1.07\ \left(\frac{N}{A}\right)^{1/2} \quad \text{(A.10)}$$

Now, in practice, the homogeneous distribution shown will not be found since population concentrations in cities tend to cluster the distribution. In such cases we would expect the actual interconnection distances to be reduced because of this coalescing of the distribution points into clusters. To account for this clustering we might introduce a clustering factor p as in Equation (A.11) where p ranges from 0 to 1.

$$m = 1.07p \left(\frac{N}{A}\right)^{1/2} \qquad \text{(A.11)}$$

A comparison of this interconnection formula to two state cable studies by the Bell System presented in Table A-19 shows the possible accuracies to be expected and the determination of an adjustment factor to correct for the

Table A-19

COMPARISON OF STATE SCHOOL CABLE INTERCONNECTION STUDIES BY THE BELL SYSTEM AND RESULTS FROM EQUATION A-10 (REF. 50)

		Missouri	South Carolina
Total number of schools		2,082	1,623
Microwave mileage		1,700	1,225
Cable Mileage		6,000	4,000
Total Survey Mileage		7,700	5,225
% Microwave	100x (1700 ÷ 7700)=	22.1%	23.5%
Area of state		69,138	30,372
Connecting survey mileage per square mile		.1111	.1724
Calculated mileage per square mile for cable and microwave from equation A-10		.1855	.248
Adjustment factor = survey mileage / calculated mileage		.60	.69

observed clustering. Without the adjustment factor these study results show a constant overestimation by the formula as expected. The uniform percentage figures in each state for the microwave interconnection component could be used to decompose total interconnection mileage in the case of cable into its microwave and cable components. The clustering factor suggested by these results is around .60. In general, however, the accuracy of this formula used with the clustering factor should be considered in lieu of more exact analysis only for rough estimates when more detailed data is unavailable.

3. Satellite for Community Interconnection. The satellite may be used in two ways for the regional distribution of programming to schools. The first is by direct reception by each school building as discussed in Section E.4 of this appendix. The second is to supply regional distribution to local centers which then redistribute the signal locally using ITFS, UHF broadcast or cable television. The cost for the resulting composite system simply adds the satellite and local distribution costs from the models which have already been developed. Estimates of ground station costs for receiving the satellite signal at each local center as given in Table A-16 should also be included in distribution costs instead of with reception costs in the case of direct reception.

4. Cost of VTR. The VTR center is an auxillary facility in the system which makes it possible to play-back tapes as desired. Tapes are kept in a video-tape library and may have originally been acquired through direct shipment, taping of earlier broadcast, etc. The important costs for the VTR center given in Table A-20 include the cost of purchasing, maintaining and operating the VTR's, building costs, and library racks.

The number of tapes in the library has been parameterized in these cost equations and the nominal cost for a 2,500 tape library of 1/2 hour tapes computed.

F. Reception Costs

Reception costs refer to the costs incurred within each school building or other institution receiving the distribution service. Equipment costs consist of room wiring costs, the purchase of television sets, and the input cost representing the local antenna and receiver costs. In addition there

Table A-20

COSTS FOR VTR CENTER

Capital Cost Formula

VTR = $2,500 · N

Building = (50 sq.ft./VTR)N + (.1 sq.ft./tape)T · $18.50/sq.ft.

Racks = $1.00/tape · T

Tape Costs = ($20 per half hour)T

Operating Cost formula:

$$\text{VTR} = \underbrace{\$5{,}000}_{\text{VTR Operator}} + \underbrace{\begin{cases} 800 \\ 1500 \\ 2800 \end{cases}}_{\text{VTR Head Repair}} + \text{Building Maintenance} + \underbrace{\begin{cases} 200 \\ 250 \\ 300 \end{cases}}_{\text{Supplies + Power + air conditioning}}$$

Where, N = number of channels

T = tape capacity of library

Typical Results (T = 2500 tapes)

Capital Cost	One Channel	Two Channel	Four Channel
VTR's	$2,500	$5,000	$10,000
Building Costs and racks	7,300	9,100	10,900
Total	$9,800	$14,100	$20,900
Operating Cost			
VTR	$5,800	$6,500	$ 7,800
Building Maintenance	200	250	300
Total	$6,000	$6,750	$ 8,100

are teacher training, and related materials costs. Teacher training costs patterned after the Hagerstown example assume 6 half day training sessions at $20 per session per teacher.* This teacher training cost as well as those for related materials and research and evaluation are the same for each distribution system and are included as estimates to achieve appropriate system cost base levels. The related materials cost assumes $15 per year for classroom materials per classroom. These cost formulas are summarized in Table A-21.

G. Total System Cost Considerations

The cost models in the previous sections allow us to determine the costs associated with a variety of television delivery systems for educational applications. Having determined the need, desirability and competence of instructional television to meet an educational application as will be demonstrated for the vocational education example, we next assess the educational system required to deliver the service. For this purpose, course schedules must be drawn up and interpreted in terms of television system requirements in utilization and channel requirements. Then knowing the number of system channels necessary for simultaneously distributing programs for different courses, we can apply the cost figures which have been developed to determine the least cost configuration. Configuration changes which provide for organizational flexibilities such as local VTR centers, tape libraries and studios can then also be evaluated against their increased cost.

The over-all costing procedure which is followed is to determine the costs for each of the boxes in Figure A.3.

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* In Hagerstown these sessions are actually planning sessions. We assume they represent basic training needs. These costs, and materials and evaluation costs are assumed to be absorbed in the regular school budgets.

Table A-21

RECEPTION COST FORMULA

Capital Costs

1. Equipment = ($80 per room) (# of rooms wired) + ($190 per TV set & Stand) X (# of rooms with TV sets) + ($500 distribution amplifier + I) X (# of Buildings)

where,

I = input cost is 1 channel, $450; 2, $475; 4, $525 for UHF

1 channel, $1900; 2, $2100; 4, $2500 ITFS

1 channel; $1200; 2, $1400; 4, $1800 Satellite

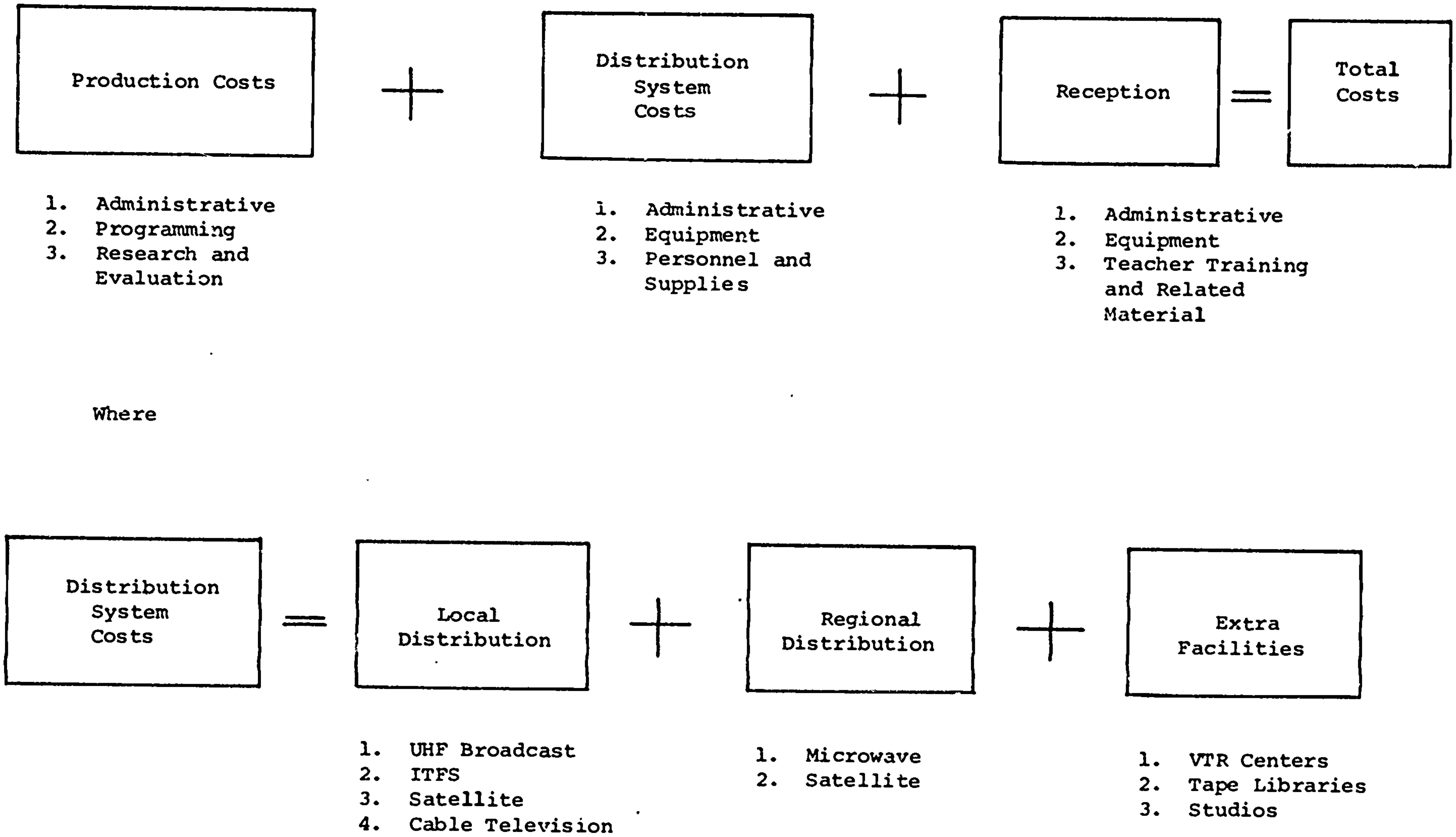
1 channel; $90; 2, $150; 4, $270 CCTV (annual hook-up charges data from Chesapeake and Potomac Telephone Company)

Operating Costs

2. Equipment = 10% of Equipment Capital Cost

3. Teacher Training = ($120 per teacher) (No. of teachers)

4. Related Materials = ($15 for materials per classroom) (No. of classrooms)



Note: Programming costs and television sets are amortized at 5% over 5 years for an annual cost factor of .231
Remaining capital costs are amortized at 5% over 10 years for an annual cost factor of .129.

Figure A-3 TOTAL COST DIAGRAM

Appendix B

COST CALCULATIONS FOR THE APPALACHIAN STATE REGIONAL ITV SYSTEMS

A. Introduction

This Appendix derives the costs for the following telecommunication systems for interconnecting public schools in the Appalachian state region,

- Cable television interconnected with microwave.
- Cable television interconnected with satellite.
- Direct satellite reception by each school.
- ITFS with microwave interconnection.
- ITFS with satellite interconnection.

The following material is presented:

- Demographic data.
- Cost reductions possible through utilization of existing facilities such as TV sets in the schools.
- Costs of the five alternative systems operating over the Appalachian states (excluding New York City). These costs are estimated for channel capacities of 1, 2 and 4. Also costs are provided for systems serving the elementary and secondary schools and for systems serving the secondary schools only.

B. Data Availability and Estimation

The objective in our cost estimation is to reflect Appalachian demographic conditions and data in each telecommunication system analysis. The effort is a first cut at estimates made prior to more detailed analysis. However, every effort was made to account for detailed descriptive demographic data. This included accounting for existing facilities where important. Since the emphasis was on demonstrating methodology, data not readily available was extrapolated and the methods for doing this explained.

Table B.1 displays the Appalachian State Educational Data obtained from

Table B-1

APPALACHIAN STATE DATA (REF. 6)

State	Total Schools 1970	Total School Districts 1970	Total Rooms 1964-65	Number of Elementary School 1970	Number of Secondary Schools 1970	Number of Combination Schools 1970	No. of Students 1970	Area (Sq. Mi.)
Alabama	1514	124	28,000	570	244	700	805,205	15,609
Georgia	881	190	37,200	1296	435	150	1,098,901	58,876
Kentucky	1610	192	23,400	1256	354	-	717,205	40,395
Maryland	1306	24	25,700	979	291	36	916,244	10,577
Mississippi	1054	150	20,900	663	391	-	534,395	47,716
New York*	4413 (2923)	760	118,100 (76,900)	3,159	1123	131	3,477,016 (2,205,395)	49,576
North Carolina	2[illegible]27	152	45,100	1,430	490	107	1,192,187	52,586
Ohio	4259	631	83,200	3,239	1018	2	2,425,643	41,222
Pennsylvania	4397	597	79,500	3,267	1130	-	2,358,100	45,333
South Carolina	1186	93	23,200	833	352	1	637,800	31,055
Tennessee	1815	147	31,400	1,329	360	126	899,893	42,244
Virginia	1794	134	24,500	1,320	445	29	1,078,754	40,817
West Virginia	1372	55	17,100	1,027	345	-	399,531	24,181
TOTALS	28682 (27138)	3,249	557,300 (516,100)	20,368	6978	1282	15,269,253	536,187

* Figures in parenthesis are adjusted for excluding New York City

Ref. 6 and Ref. 34. All of the columns of this data refer to 1970 except the total rooms data used from 1964-65. In addition, the New York State data has been adjusted to exclude New York City in order to reduce the resulting disparities between this State and others. The method of adjustment was to proportion on (number of students excluding New York City)/(number of students in the state) multiplied by the appropriate entry.

Data on existing facilities was obtained from Ref. 32 as summarized in Table B-2.

The principal use of Table B-2 was to estimate how many schools were currently wired for television and how many instructional rooms had television sets. Close investigation of this data on existing facilities reveals some lack of consistency which validates its use only in a first approximation to existing facilities. For example, North Carolina reports 45% of its elementary schools and 52% of its secondary schools have TV receivers for classroom use. However, in the distribution of TV receivers section North Carolina reports 75% of its schools have no TV sets. From this analysis, an estimation was obtained for how many additional schools needed to be wired and rooms provided with television sets so that half of all rooms have television sets. To estimate how many schools were wired for television, the percent of schools using broadcast TV was used. This tends to underestimate the number of schools actually wired since some may be wired exclusively for ITFS or CATV. However, it does imply some wiring has taken place in the building which isn't necessarily true for TV receivers operated, for example, from VTR in a simple CCTV system. The results for the estimated number of schools remaining to be wired in each state is indicated in Table B-3.

Another substantial investment in existing facilities consists of classroom receivers. Table B-2 gives the distribution of TV receivers in the Appalachian state schools. Assuming a receiver in every other room to support the four channel level of ITV envisioned, we can determine the required purchase of television receivers necessary to reach this level. Using 30 students per room, the average population of schools in each distribution category can be converted into television set requirements

Table B-2

SUMMARY OF RESULTS OF STATE ITV SURVEY
(REF. 32)

State	Percent of Schools in the Entire State that have TV Receivers for Classroom Use		Percent of Schools in the Appalachian Part of the State that have TV Receivers for Classroom Use		Average Number of TV Receivers in the Schools in the Appalachian Part of the State		Remarks
	Elementary Schools	Secondary Schools	Elementary Schools	Secondary Schools	Elementary Schools	Secondary Schools	
Alabama	95	90	98	93	10	5	
Georgia	96 (combined)		95 (combined)		8.31	4.49	
Kentucky	86	40	70	35	9	2	
Maryland	--	--	60	60	7.3	6.6	Three counties in the ARC area.
Mississippi	--	--	--	--	----	---	Data not available
New York	75	65	68	65	4.5	4	
North Carolina	45	52	25	24	0.45	0.6	
Ohio	70	60	65	33	5	3	
Pennsylvania	100	97	100	100	1	1	
South Carolina	60	45	65	40	3	5	
Tennessee	80	50	95	60	6	2	
Virginia	--	--	--	--	----	---	Data not available
West Virginia	55(combined) 75% of the schools with TV sets are elementary schools				3 21 of the 55 county school systems do not have any TV sets at all. Uneven distribution of sets.		Questionnaire was not completed in desired form

Table B-2
(continued)

State	Distribution of TV Receivers								Percentage of Public Schools Using ITV Programs		Remarks
	0		1 - 4		5 - 9		10+				
	% of schs	Av pop of sch	% of schs	Av pop of sch	% of schs	Av pop of sch	% of schs	Av pop of sch	Elementary Schools	Secondary Schools	
Alabama	5	200	20	280	60	320	15	700	90		
Georgia	2.9	---	25.4	---	46.1	---	25.6	---	95 (combined)		
Kentucky	40	350	10	350	25	400	25	500	84	38	
Maryland	33	---	26	---	6	272	27.3	510	50	33	Hagerstown numbers raise the state numbers
Mississippi	--	---	--	---	--	---	--	---	--	--	No data available
New York	5	850	48	591	40	945	7	1000	72	72	
North Carolina	75	529	25	529	0	0	0	0	38	42	
Ohio	35	125	20	200	40	400	5	700	45	20	
Pennsylvania	0	---	10	---	15	---	75	---	90	47.7	
South Carolina	25	250	50	350	15	600	10	800	60	35	
Tennessee	8	175	10	150	60	250	22	500	80	50	
Virginia	--	---	--	---	--	---	--	---	--	--	No data available
West Virginia	--	---	--	---	--	---	--	---	--	--	Data not available

Table B-2
(continued)

State	Methods of Television Dissemination (percent of schools using the following)				Distribution of VTRs (percent of schools in each category)					Percent of CCTV Installations being simply a VTR and a camera
	CCTV	ITFS	Broadcast TV	CATV	0	1	2	3	4+	
Alabama	20	30	90	40	50	25	10	8	7	80
Georgia	19.1	0	100	25	66	12.5	8.5	2.5	10.5	19.1
Kentucky	3	1	48	8	94	5	1	0	0	90
Maryland	- - - -	- - - -	- - - - - - - no	data	available			- - - -	- - - -	- - - - - - - - - -
Mississippi	- - - -	- - - -	- - - - - - - no	data	available			- - - -	- - - -	- - - - - - - - - -
New York	48	0	74	41	35	23	15	10	17	52
North Carolina	1	0	24	3	98	2	0	0	0	1
Ohio	3	0	65-elem. 33-sec.	40	80	12	5	3	0	100
Pennsylvania	--	0.01	70	30	--	70	30	--	--	80
South Carolina	35	--	65	--	73	10	10	5	2	5
Tennessee	2	0	95	used only for reception of Br TV	80	15	5	--	--	50
Virginia	- - - -	- - - -	- - - - - - - no	data	available			- - - -	- - - -	- - - - - - - - - -
West Virginia				one station is carried over 100 systems	-a total of 150 VTRs-					

Table B-2
(continued)

State	Average hours/week ITV viewing by students		Problems foreseen in acceptance of quality ITV programs delivered from a centralized source out of state	Kinds of additional programming that would be desirable
	Elementary Students	Secondary Students		
Alabama	5	1	For instructional material of supplementary nature, no problems are anticipated. For the ones designed for basic instruction, there might be some conflicts with the state course of study and legal limitations imposed by the State Department of Education and the state legislature.	Current events, high school biology, ecology, aerospace education, basic adult education, conversational foreign languages, drug abuse, driver educatio elementary reading, etc.
Georgia	0.8		None if the material meets local needs and local inputs are obtained during development.	No data available.
Kentucky	1	0.33	Program material would need the approval of the Kentucky Department of Education.	Currently produced science programs, currently produced mathematics programs, health courses, contemporary affairs, and teacher in-service programs.
Maryland	--	--	---	High school equivalency.
Mississippi	--	--	---	---
New York	3.4	1.4	Coordination of curriculum material and school schedules.	Drug abuse, environment, health education, child development--parent education, culture-humanities, high school equivalency, business, and industrial-vocational-trade courses.
North Carolina	2.5	1.0	State-to-state differences in curriculum content. It will be desirable to design programs in non-sequential modules to be used as supplementary resource material.	Pre-school and early childhood education, career education K-12, current events, health education, science, cultural arts, and selected topics in other curriculum areas.
Ohio	1.5	1.0	Participation of curriculum specialists from the Appalachian region is necessary in the design and validation of ITV programming.	Health education, career motivation, mathematics, and self-awareness.
Pennsylvania	8	2	Involvement of State Department of Education in course development.	Science, current events, ecology, history.
South Carolina	6	2	None.	Reading, health-education, and human relations.
Tennessee	3	0.5	Problems of curriculum control if a large part of TV offerings came from one national source	Health education and language arts.
Virginia	- - - - no response - - - -			
West Virginia	0.5-0.75	0.5	No problems as long as local schools are involved in selection.	---

Table B-3

INCREASE IN DISTRIBUTION OF TV RECEIVERS TO ACHIEVE ONE IN EVERY TWO ROOMS

	Assumed Existing TV Receivers per School					
	0			2.5		
State	Percent of schools	Required TV Sets	Additional TV Sets	Percent of schools	Required TV Sets	Additional TV Sets
Alabama	5	3.3	3.3	20	4.7	2.2
Georgia	2.9	9.9	9.9	25.4	9.9	7.4
Kentucky	40	5.8	5.8	10	5.8	3.3
Maryland	33	9.8	9.8	26	9.8	7.3
Mississippi*	100	9.9	9.9	0	—	0
New York (exclude New York City)	5	14.2	14.2	48	9.9	7.4
North Carolina	75	8.8	8.8	25	8.8	6.3
Ohio	35	2.5	2.5	20	3.3	.8
Pennsylvania	0	—	0	10	9	6.5
South Carolina	25	4.2	4.2	50	5.8	3.3
Tennessee	8	2.9	2.9	10	2.5	0
Virginia*	100	6.8	6.8	0	—	0
West Virginia*	100	6.3	6.3	0	—	0

*Assumed there are no existing television sets because of lack of more specific data.

per school. Subtracting the number of television sets taken to be present in each category yields the additional number required. The results are displayed in Table B-3. When figures for the average population of schools falling in each distribution category were not given, as for Maryland, average population per school values for the entire State were used. The last column gives the expected number of TV sets to be added to each school to achieve the desired level of one TV set for every two instructional rooms.

Similar data for VTR equipment in each school is also indicated in this table and could be used as for TV set data to estimate existing hardware applicable to forming local VTR centers and libraries. However, due to tape decks and the emergence of new inexpensive equipment of high quality, the hardware for such video tape recording centers would probably be bought expressly for that purpose.

Percentages are also given defining percentages of schools currently using CCTV, ITFS, Broadcast TV and CATV. With the exception of Broadcast TV, and CCTV, installations being simply a VTR and a camera, we would expect the remaining facilities to be mutually exclusive in serving an area. The CATV facilities are expected to be providing single channel capability and not the flexibility required for four channel ITV programming. Therefore, existing CATV will not be considered as being used currently in that application. The remaining per cent of the schools using CCTV and ITFS for ITV are given in Table B-4. Only one state, Alabama, reports major use of ITFS in 1972. According to Ref. 33, four ITFS systems are listed in Alabama as of Janauary 1971 serving approximately 15% of the students. The formula developed in Appendix A indicates around 80 ITFS stations will be needed for the State. Therefore, we estimate that there exist now in the neighborhood of about 10% of the ITFS transmitter systems and 30% of the school ITFS receiver systems needed for state-wide coverage.

The CCTV systems may likewise be used to estimate the magnitude of cost reduction to be expected fro existing facilities. More detailed analysis based on the demographics of existing facilities will be necessary, however, to improve accuracies. For the present, the CCTV system cost can be prorated on a mile per school cost basis to estimate the value of existing facilities.

Table B-3 (Cont.)

INCREASE IN DISTRIBUTION OF TV RECEIVERS TO ACHIEVE ONE IN EVERY TWO ROOMS

State	Assumed Existing TV Receivers per School: 7			10			Computed Average Additional TV Sets Increase per School
	Percent of Schools	Required TV Sets	Additional TV Sets	Percent of Schools	Required TV Sets	Additional TV Sets	
Alabama	60	5.3	0	15	11.7	1.7	.86
Georgia	16.1	9.9	2.9	25.6	9.9	0	3.47
Kent	25	6.7	0	25	8.3	0	.562
Maryland	6	4.5	0	27.3	8.5	0	5.2
Mississippi*	0	---	0	0	---	0	9.9
New York (exclude New York City)	40	15.8	8.8	7	16.7	6.7	8.25
North Carolina	0	---	0	0	---	0	8.175
Ohio	40	6.7	0	5	11.7	1.7	1.115
Pennsylvania	15	9.0	2.0	75	9	0	.95
South Carolina	15	10	3.0	10	13.3	3.3	3.48
Tennessee	60	4.2	0	22	8.3	0	.23
Virginia*	0	---	0	0	---	0	6.8
West Virginia*	0	---	0	0	---	0	6.8

*Assumed there are no existing television sets because of lack of more specific data.

Table B-4

APPROXIMATE PER CENT USE BY SCHOOLS OF CCTV AND ITFS

STATE	CCTV	ITFS	TOTAL
Alabama	4	30	34
Georgia*	0	0	0
Kentucky	.3	0	.3
Maryland**	0	0	0
Mississippi**	0	0	0
New York	25	0	25
North Carolina	0	0	0
Ohio	0	0	0
Pennsylvania	0	0	0
South Carolina	33	0**	33
Tennessee	2	0	2
Virginia**	0	0	0
West Virginia**	0	0	0

* The 19.1% of CCTV Installation reported in Table B-2 as being simply a VTR and a camera and the 19.1% of CCTV school usage is questionable Therefore, it is assumed in error and 100% of CCTV installations are assumed to be VTR.

** These are assumed since no data was given.

This approach ignores the fact that existing CCTV systems are most likely in densely populated areas where the interseparation distances are less. However, it does allow us to estimate the magnitude of cost reductions reflected in existing CCTV facilities.

C. ITV System Design Calculations

Cost models have been developed in Appendix A which allow us to perform total systems costing. The objective in this effort has been to clearly state system design assumptions in a manner allowing them to be questioned and changed where desired. Matters of disagreement in cost results can thus be traced to component parts and more easily resolved. This establishes credibility in the methodology rather than particular state-of-the-art cost figures chosen. When possible, expected range of costs are given rather than a fixed value as in the case of satellite cost.

Another aspect of cost, i.e, their uncertainty, was also important in defining the approach taken. Different accuracies are present in our ability to define the costs of the hardware, administrative or programming components. For this reason, these components will be displayed separately in our ensuing cost calculations using the cost approaches developed in Appendix A.

One of the more important hardware components calculated is the mileage of terrestrial microwave and cable required to interconnect all the schools in a state. This calculation uses a cable distribution model developed as Equation (A-11) in Appendix A with a clustering factor of .60. This clustering factor was used to fit the theoretical model to the results obtained in Bell System Studies for two States: Missouri and South Carolina. The microwave component of this interconnection distance represents 23% of the total mileage and is an estimate found to hold in both the Missouri and South Carolina cases. Converting this microwave interconnection distance for a given area back into the number of points producing it gives an estimate of the separate number of cable systems involved.

To determine the number of ITFS systems required in a state, the area of coverage of 300 sq. mi. was divided into total area to yield an upper bound on the expected number of ITFS systems. Then since the range of coaxial cable and ITFS are both around 20 miles in diameter due to repeater amplifier noise in the first and limited transmitter power in the second, we take as many ITFS systems as there are cable systems. However, if this number exceeds the ITFS upper bound, then we use the upper bound to represent the number of ITFS systems.

The results of these calculations for cable and ITFS systems is shown in Table B-5. It is easily determined that in this design method there are approximately twenty schools per ITFS and cable system.

D. Basic Cost Calculation For a System To Interconnect all Public Elementary and Secondary Schools in the Appalachian States.

The following cost calculations are displayed to demonstrate how the cost models in Appendix A can be applied to deriving system cost estimates for the following systems over the Appalachian state region:

- cable television interconnected with microwave
- cable television interconnected with satellite
- direct satellite reception at every school
- ITFS with microwave interconnection
- ITFS with satellite interconnection

The resulting cost calculations are displayed in Tables B-6 through B-9.

E. Basic Cost Calculations For System To Interconnect Only Secondary and Combined Schools in the Appalachian States.

In vocational education applications, we are principally interested in only the secondary education system since most vocational education takes place there. A natural question we might ask ourselves is what cost reduction we might expect if we set up a system for ITV distribution only to secondary schools. Since there are around three elementary schools to each secondary school we would expect considerable c- t savings. This section repeats the calculations of the preceding secti for the secondary school only case. Combined secondary-elementary schools for the purpose of this analysis are treated as secondary schools.

The clustering factor of .6 developed in Appendix A was derived from total school systems designs. In the present application, we must make some interpretation as to how it should be applied to only the secondary schools case. First, we expect that the microwave interconnection network would remain constant because we have the same regional clustering of schools being

Table B-5

CALCULATION RESULTS FOR CABLE AND ITFS SYSTEMS
INTERCONNECTING ELEMENTARY AND SECONDARY SCHOOLS IN APPALACHIAN STATES

State	Cable System: Cable (mi.)	Cable System: Microwave Interconnected (mi.)	I No. Cable System	II Number of ITFS at 300 sq. mi.	Number Using Minimum of I and II	ITFS Microwave Interconnection (mi.)
Alabama	4380	1305	80	172	80	1305
Georgia	5200	1550	99	196	99	1550
Kentucky	3990	1189	85	135	85	1189
Maryland	1840	548	69	35	69	548
Mississippi	3510	1045	56	159	56	1045
New York*	7300 (6180)	2180 (1780)	232 (155)	165	165 (155)	1835 (1670)
North Carolina	6630	1980	180	175	175	1970
Ohio	6550	1960	226	137	137	1520
Pennsylvania	6980	2080	233	151	151	1675
South Carolina	3000	895	62	103	62	895
Tennessee	4330	1290	96	141	96	1290
Virginia	3620	1080	69	136	69	1080
West Virginia	2850	850	73	81	73	850
	60,180 (59,060)	17952 (17,552)	1,560 (1483)		1,317 (1,307)	16,752 (16,587)

* Figures in parenthesis are adjusted for excluding New York City

TABLE B-6

ADMINISTRATIVE COSTS

Each cable and ITFS system serves on the average approximately 20 schools and 10,000 students. The following administrative costs for each of these local distribution systems are chosen:

Manpower		
	Director @ $12,000	$12,000
	Assistants (2) @ $9,000	18,000
Subtotal		$30,000
20% Overhead		6,000
Total		$36,000

State and regional chosen same as in Table A-3. Therefore, the following administrative cost estimates are obtained.

Cable: 1423 cable systems X $26,000/cable system + 13 states X $42,000/ state + $54,000 regional = $51.8 X 10^6.

ITFS: 1307 ITFS systems X $36,000/ITFS system + 13 states X $42,000/ state + $54,000 regional = $47.6 X 10^6.

Satellite: Assumed same as ITFS = $47.6 X 10^6.

Table B-7

RECEPTION COSTS

ALL-SCHOOL SYSTEM

1) Total Costs (in $10^6)

	Capital	Annual Capital	Operating (10% Capital)
Wiring (516,100 rooms at $80 ea.)	$41.3	$ 5.32(10 yr-5%)	$ 4.13
TV set (258,000 sets at $190 ea.)	49.0	11.30(5 yr-5%)	4.90
Distribution Amp(27138 schools at $500 ea.)	13.5	1.74(10 yr-5%)	1.35
		$18.36	$10.38

Total Annual Costs = $18.36 + $10.38 = $28.74

2) Accounting for Existing Facilities (in $10^6)

	Capital	Annual Capital	Operating
Wiring (246,570 rooms at $80 ea.)	$19.7	$2.54	$1.97
TV set (104,738 sets at $190 ea.)	19.9	4.60	1.99
Distribution Amp. (13,489 schools at $500 ea.)	6.8	.88	.68
		$8.02	$4.64

Total Annual Costs Additional = $8.02 + $4.64 = $12.66

Table B-8

ANNUAL DISTRIBUTION SYSTEM COSTS (IN $\$10^6$)
FOR APPALACHIAN STATE REGION EXCLUDING NEW YORK CITY
(ALL SCHOOL SYSTEM)

	Channels 1	Channels 2	Channels 4
1. Cable with Microwave Interconnection Channels:			
Cable (total 59,060 miles)	$44.4 ($750/mi.)	$56.8 ($960/mi.)	$73.5 ($1248/mi.)
Hookup (total 27,138 schools)	2.4 ($90 ea.)	4.1 ($150 ea.)	7.3 ($270 ea.)
Microwave (17,552 miles)	5.8 ($330/mi.)	8.4 ($480/mi.)	13.2 ($750/mi.)
Additional State Interconnection (2,820 miles)	.9	1.4	2.1
Total	$53.5	$70.7	$96.1
2. Cable with Satellite Interconnection:			
Cable (above)	$44.4	$56.8	$73.5
Hookup (above)	2.4	4.1	7.3
Ground Receive (Capital: 1483 systems at $1200)x (.129 annual cap. + .1 operate)	.4 ($1200 ea.)	.5 ($1400 ea.)	.6 ($1800 ea.)
Ground Transmit (Capital: $\$10^6$) x (.129 + .1)	.2	.2	.2
Satellite Channel per year	1.5	3.0	6.0
Total	$48.9	$64.6	$87.6

Table B-8
(continued)

	Channels 1	2	4
3. Direct Satellite Reception:			
Ground Receive (27,138 schools at $1200) X (.129 + .1)	$7.4 ($1200 ea.)	$ 8.7 ($1400 ea.)	$11.2 ($1800 ea.)
Ground Transmit (above)	.2	.2	.2
Satellite Channel per year	1.5	3.0	6.0
Total	$9.1	$11.9	$17.4
VTR Center for Each School Served by Satellite (27,138 schools)	$197	$232	$293
4. ITFS with Microwave Interconnection:			
ITFS Annual Capital (1307 stations)	$9.4 (@$7200)	$11.6 (@ $8900)	$16.5 (@ $12,600)
ITFS Operation	14.1 (@ $10,800)	14.9 (@ $11,400)	17.0 (@ $13,000)
ITFS Receive Equipment (27,138 schools at $1,900) X (.129 + .1)	11.8 (@ 1,900)	13.0 (@ $2,100)	15.5 (@ $2,500)
Microwave Interconnection (16,587 miles)	5.5 ($330/mi.)	8.0 ($480/mi.)	12.4 ($750/mi.)
Additional State Interconnection Microwave (2820 miles)	.9	1.4	2.1
Total	$41.7	$48.9	$63.5

Table B-8
(continued)

	Channels 1	2	4
5. ITFS with Satellite Interconnection:			
ITFS Annualized Capital (above)	$9.4	$11.6	$16.5
ITFS Operations (above)	14.1	14.9	17.0
ITFS Receive Equipment (above)	11.8	13.0	15.5
Ground Receive From Satellite (1307 at $1200) x (.129 + .1)	.4 (@ $1,200)	.4 (@ $1,400)	.5 (@ $1,800)
Ground Transmitter $\$10^6 \times (.129 + .1)$	.2	.2	.2
Satellite Channel per year		3.0	6.0
Total	$37.4	$43.1	$55.7

Table B-9

TOTAL BASIC COSTS FOR APPALACHIAN STATE
FOUR CHANNEL ALL SCHOOL INTERCONNECTION SYSTEMS
(in millions of dollars)

Cable with microwave	
Administrative (Table B-6)	$51.8
Reception (Table B-7)	28.7
Distribution (Table B-8)	96.1
Programming (.10 hrs/wk x 36 wks x $6000/hrs) amortized over 5 years at 5%	6.0
Total Annual Cost	$182.60
Cable with satellite	
Administrative (Table B-6)	$51.8
Reception (Table B-7)	28.7
Distribution (Table B-8)	87.6
Programming (above)	6.0
Total Annual Cost	$174.1
Satellite	
Administrative (Table B-6)	$47.6
Reception (Table B-7)	28.7
Distribution (Table B-8)	17.4
Programming (above)	6.0
Total Annual Cost	$ 99.7
VTR Centers	$293
ITFS with microwave	
Administration (Table B-6)	$47.6
Reception (Table B-7)	28.7
Distribution (Table B-8)	63.5
Programming (above)	6.0
Total Annual Cost	$145.8
ITFS with satellite	
Administration (Table B-6)	$47.6
Reception (Table B-7)	28.7
Distribution (Table B-8)	55.7
Programming (above)	6.0
Total Annual Cost	$138.0

considered with fewer schools at each local cluster. Therefore, the long haul microwave distance shouldn't change whereas the local cable mileage would be reduced since there are now fewer schools locally in the secondary schools only case. The formula for this cable length is given in Appendix A In Equation (A-11) as length = $1.07p\sqrt{NA}$. Now since the area A remains the same and assuming the clustering constant p remains constant, we have $L_{all}/L_s = \sqrt{N_{all}/N_s}$ where L and N are the cable length and number of interconnection points for all the schools denoted "all" and for "s" denoting secondary only. The resulting modification to cable length suggested by this approach is $L_s = L_{all}\sqrt{N_s/N_{all}}$.

For the ITFS system whose coverage is limited by transmitter power, we assume the same number of transmitters will be required in the secondary only case as for all schools. However, there will be accordingly fewer receiver locations in the secondary only case.

Using these modifications, we can apply the cost models in Appendix A to cable and ITFS systems to obtain the results in Table B-10 through B-12.

Table B-10

ANNUAL RECEPTION COST IN THE APPALACHIAN STATES
FOR THE SECONDARY ONLY SCHOOL CASE (IN MILLIONS OF DOLLARS)

	Capital	Annualized Capital	Operations
1. Total Cost			
Wiring (all rooms--280,100) at $80 ea.	$22.4	$2.89	$2.24
TV Set (1/2 all rooms) at $190 ea.	26.6	6.1	2.66
Distribution Amp. (7847 schools at $500 ea.)	3.9	.5	.39
		$9.49	$5.29
Total Annual Cost = $9.49 + $5.29 = $14.78			
2. Approximate Cost Accounting for Existing Facilities*			
Wiring (134,000 rooms at $80 ea.)	$10.7	$1.38	$1.07
TV Set (57,000 at $190 ea.)	10.8	2.50	.97
Distribution Amp. (3700 schools at $500 ea.)	1.9	.24	.19
		$4.12	$2.23
Total annual cost = $4.12 + $2.23 = $6.35			

* Proportions Based on All School Results

Table B-11

ANNUAL DISTRIBUTION SYSTEM COST FOR
FOUR CHANNEL SYSTEM TO SECONDARY SCHOOLS ONLY

Cable with Microwave		
Cable (32,090 mi.)	$40.0	($1248/mi.)
Hookup (7847 schools)	2.1	($270 ea.)
Microwave (17552 mi.)	13.2	($750/mi.)
Additional State Interconnecting Microwave (2820 mi.)	2.1	
Total Annual Cost	$57.4	
Cable with Satellite		
Cable	$40.0	
Hookup	2.1	
Ground Transmitter @ $\$10^6$ x (.129 + .1)	.2	
Ground Receive $1800 ea. (1483 cable system) x (.129 + .1)	.6	
Satellite Channel per year	6.0	
Total Annual Cost	$48.9	
Total Satellite		
Ground Receive $1800 ea. (7847 schools) x (.129+.1)	$3.2	
Ground Transmitter	.2	
Satellite Channel per year	6.0	
Total Annual Cost	$9.4	
VTR Center for Satellite	$84.7	
ITFS with Microwave		
ITFS Annualized Capital	$16.5	
ITFS Operations	17.0	
ITFS Receive	4.5	
Microwave Outputs (1307 Station)	.4	
Microwave (16,537)	12.4	
Additional State Microwave	2.1	
Total Annual Cost	$52.9	

Table B-11 (Cont.)

ITFS with Satellite	
ITFS Annualized Capital 1307 Stations	$ 16.5
Operations	17.0
ITFS Receive Equipment	4.5
(7847 @$2500) x (129+.1)	
Ground Receive Antenna	.5
(1307 @$1800) x (.129+.1)	
Ground Transmitter $\$10^6$ x (.129+.1)	.2
Satellite Channel per year	6.0
Total Annual Cost	$44.7

Table B-12

TOTAL BASIC COSTS FOR APPALACHIAN STATE FOUR CHANNEL SECONDARY SCHOOL ONLY INTERCONNECTION SYSTEM (In Millions of Dollars)

Cable with Microwave	
Administrative (Table B-6)	$51.8
Reception (Table B-9)	14.7
Distribution (Table B-10)	57.4
Programming (120 hrs/wk x 36 wk x $6000/hr) amortized over 5 yrs. at 5%	6.0
Total Annual Cost	$129.9
Cable with Satellite	
Administrative (Table B-6)	$51.8
Reception (Table B-9)	14.7
Distribution (Table B-10)	48.9
Programming (above)	6.0
Total Annual Cost	$121.4
Satellite	
Administrative (Table B-6)	$47.6
Reception (Table B-9)	14.7
Distribution (Table (B-10)	9.4
Programming (Above)	6.0
Total Annual Cost	$77.7
VTR Centers	$84.7
ITFS with Microwave	
Administrative (Table B-6)	$47.6
Reception (Table B-9)	14.7
Distribution (Table B-10)	52.9
Programming (Above)	6.0
Total Annual Cost	$121.2
ITFS with Satellite	
Administrative (Table B-6)	$47.6
Reception (Table B-9)	14.7
Distribution (Table B-10)	44.7
Programming (Above)	6.0
Total Annual Cost	$113.0

Appendix C

SCHEDULING ALTERNATIVES

A. Costs

Programming types can be divided into three categories: local programming, high-use medium quality, and highest quality. Local programs are done on a low budget and on an ad hoc basis. We assume their cost to be $600 per hour though estimates run from $100 to $1000 per hour. Medium quality programming costs run $6000 per hour. Highest quality programming costs generally run $60,000 per hour.

In more mature stages of ITV broadcasting a market will develop in programs and their costs to users will drop somewhat so that a higher proportion of highest quality programming will become economically feasible. In the early phases we will assume that programming costs are spread over the whole nation and amortized over three years at 5% interest. Hence annual cost per hour of programming to Appalachian states is $7,340 per hour for highest quality programming, $734 per hour for medium quality programming. We don't expect that local programming can be costed to the whole nation nor can it be amortized over three years. Actually very elaborate high quality programs may cost more than $60,000 per hour but they probably will be useful for more than 3 years so the annual cost figures probably are appropriate.

B. A Heavy Usage Program

For very heavy usage of ITV, a program such as the following might be encountered: Assume that each student in first four grades has 20 20-minute lessons per week. Each student in middle four grades has a choice of two sets of 20 20-minute lessons. High school students will each have 21 lessons per week. Assume 1/3 of lessons go to all students or 7 lessons per week are taken by all students. Assume that half of the students take college preparatory courses with 7 common lessons per week and with three sets of options such as arts, science and professional. Assume that final half of students take vocational education with 7 common lessons and with thirty sets of options of 7 lessons each. The summary of total numbers of courses is given in Table C-1.

Table C-1

NUMBERS OF ITV LESSONS/WEEK FOR VARIOUS AGE GROUPS IN A HIGH USAGE PROGRAM

	Student Courses/week	# Options	Total #/wk/grade	# For All Four Grades
First Four Grades	20	1	20	80
Middle Four Grades	20	2	40	160
High School Common Courses	7	1	7	28
High School Common College	7	1	7	28
High School College Options	7	3	21	84
High School Voc. Ed. Common	7	1	7	28
High School Voc. Ed. Options	7	30	210	840
Total lessons week All Programs				1248

With no duplication and half-hour scheduling 60 lessons per week can be broadcast per channel. Thus 21 channels are needed to deliver all options with no rebroadcast capability.

The annual cost for programming can be calculated assuming 20-minute lessons and highest quality programs except for the 30 options of vocational education which are middle quality programs.

$408 \times 12 \times 7340 = \$35.80 \times 10^6$/yr. for large enrollment highest quality program

$840 \times 12 \times 734 = \$\ 7.40 \times 10^6$/yr. for small enrollment medium quality program

The overall programming costs to the Appalachian states are $\$43.20 \times 10^6$ per year.

To give a feeling for the numbers of vocational option courses needed Table C-2 lists the number of vocational courses offered in a typical California junior college.

C. A Lighter Usage Program

If the same program were utilized with 10 lectures/week with the same relative options the programming costs would be cut in half and the number of satellite channels would be cut in half. If 21 channels were still utilized substantial rebroadcast capability could be made available for the 10 lectures/week system.

A second alternative lighter usage system would be obtained by leaving all options the same as for the heavy utilization system and cutting vocational education options to 10 from 30. The programming costs would then be reduced by $4.93 million per year. This is a small proportion of the total amount of $43 million. The satellite channel capacity would be reduced by 9 channels by such a change. The result of this choice is to illustrate that vocational education options cost little except channel capacity in the distribution system.

A third lighter usage program is illustrated in Table C-3. Based on 8 lessons/week with two college preparatory options and with 8 vocational education options this program can fit on a 4 channel distribution system. Table C-3 illustrates several options.

D. Summary of Channel Capacity, Class Enrollments, Programming Costs, and Teacher Time Savings for Various Programs

Once an ITV system is put into operation there are a number of programs which it can sustain. Generally the more excess channel capacity available the more flexibly the programs can be scheduled. The purpose of this section is to summarize the various programming options as to their minimum channel requirements, programming costs, class sizes, and teacher time savings.

Class sizes for a 1500-student school are illustrated for various programs in Table C-4. The vocational education class sizes are so small that the use of ITV is clearly needed. Obviously classes for adjoining years could be combined to get manageable groups. The ITV options clearly make such flexibility feasible. Many rural schools will be smaller than the 1500 size.

Table C-2

HOURS OF INSTRUCTION AT A TYPICAL JUNIOR COLLEGE
VOCATIONAL EDUCATION PROGRAM IN CALIFORNIA

Program	Lecture	Lecture-Demonstration	Laboratory or Project	Practice (Field)
Vocational Nursing	400		990	
Medical Assistant	180	200	320	240
Pediatric Specialty	70		20	210
Inhalation Therapy Technology	250		320	760
Engineering	930	190	1330	
Math for Voc. Ed.	290			
Computer Programming	360			
Transportation	300			
Quality Control	600			
Automotive Mechanics	220	1050	630	
Business	690		520	
Recreation	300		300	
Real Estate	400			
Photography	290		240	
Home Economics	250	250	120	

Table C-3

NUMBERS OF ITV LESSONS/WEEK FOR VARIOUS AGE GROUPS
IN TWO LOWER USAGE PROGRAMS

Grade	Student Courses/wk	Number of Options	# Lessons/wk/grade	# Lessons/wk for all grades
First Four Grades	8	1	8	32
Middle Four Grades	8	2	16	64
High School Common Courses	3	1	3	12
High School Common College prep.	3	1	3	12
High School Options College prep.	3	3 (2)	9 (6)	36 (24)
High School Common Voc. Ed.	3	1	3	12
Total Lessons/wk High enrollment Courses				168 (156)
High School Voc. Ed. Options	3	30 (8)	90 (24)	360 (96)
Total Lessons/wk All Courses				528 (252)

Table C-4

SUMMARY OF CHANNEL CAPACITY, CLASS ENROLLMENTS, PROGRAMMING COSTS AND TEACHER TIME SAVINGS FOR VARIOUS PROGRAMS

Program Characteristics				Minimum Channel Capacity Required	Program Costs in Millions of Dollars per year	Average No. of Students taking each lesson (School of 1000 elem. and 500 high school)					Estimated Millions of Teacher Hours Saved per year	Estimated Millions of Teacher Hours total instruction/year
Lessons/wk (elem.)	Lessons/wk (high school)	College Prep. Options	Voc. Ed. Options			First Four Grades	Middle Four Grades	Common High School	College Prep. Option	Voc. Ed. Option		
8	9	2	8	4	14.60	125	63	125	31	8	31.2	540 (all programs)
8	9	3	30	9	17.97	125	63	125	21	2	33.6	
10	10.5	3	10	6	19.20	125	63	125	21	6	40.8	
10	10.5	3	30	9	21.60	125	63	125	21	2	40.8	
20	21	3	10	12	38.40	125	63	125	21	6	81.6	
20	21	3	30	21	43.20	125	63	125	21	2	81.6	

The class sizes of course scale directly with school size. The county enrollments data given in Table II-2 in this report are representative.

One very significant advantage to the use of ITV is the amount of teacher time it saves. Each twenty minute lesson was assumed to be scheduled so as to save ten minutes of teacher time. This saving could be achieved by teachers combining classes for viewing or by having one teacher monitor two ITV lessons simultaneously or by having a teacher-in-training or a paraprofessional monitor the viewing classes. To compute the estimated teacher time saved we assume class sizes of 25 students and simply compute the number of viewing classes per week. Each class would represent 10 minutes of teacher time saved. (Because about 1/3 of the schools were rural schools, it was assumed they were too small to arrange to save teacher time.) Actually these teachers probably achieve greatest benefits from ITV because they have very high course schedules. No assumption of saved teacher preparation time was made because ITV was assumed to involve just as much intellectual effort from the teacher as regular teaching but it would occur in different ways.

The teacher time saved must be much less than total instruction time. This total class instruction time was calculated by finding the number of 25-student classes in 1[illegible] million students taking 25 one-hour classes per week. Because of scheduling problems, this estimate may be low.

Appendix D

PROPOSAL OUTLINE
OUTPATIENT HEALTH EDUCATION PROGRAM EMPHASIZING TELECOMMUNICATIONS
GRADY MEMORIAL HOSPITAL, ATLANTA, GEORGIA

A. Societal Need

1. One of the problems faced by large urban public hospitals in trying to meet the health needs of a largely indigent population is a lack of basic health knowledge within this population. Within the framework of the clinic setting -- which involves treatment of specific illnesses -- it has been difficult to introduce the fundamental health maintenance topics normally covered in public school courses. It is well recognized that many of the acute episodes which must be resolved in the hospital's clinics might have been prevented if the patient had had access to basic health education. While it has not been considered the responsibility of hospitals to insure that health education is available to the entire population, it does fall the lot of the hospital to engage in crisis intervention in situations which might have been averted given appropriate health maintenance knowledge on the part of the patient.

2. Additionally, in a hospital with an average daily outpatient census of 1600 (excluding 600 to 800 emergency patients), there are large groups of patients with the same disease who must be taught to deal with their specific problems, e.g., heart disease, diabetes, arthritis, epilepsy. Much of this teaching may be done most expeditiously in groups.

B. Specific Proposal Objective

1. Because all ambulatory care necessarily involves some waiting time for patients, it is our intent to use this time for basic health education in order to improve the general health knowledge of our patient population. The primary medium would be telecommunications, using cassette players.

Since most of the existing health information programming does not meet the needs of the indigent patients, it would be our intent to develop programs relevant to this population. If our efforts are judged successful, the tapes could be made available to other health providers who are working with similar patient populations.

2. Patients who share a common disease syndrome would be shown video tapes carrying instructions on how to deal with their specific problems. This particular use of telecommunications would augment individual and group teaching programs now in effect.

C. Technical Approach Suggested

1. Demonstration Site Description

Grady Memorial Hospital is a 1000 bed hospital with 142 clinics located in downtown Atlanta. It is operated by the Fulton-DeKalb Hospital Authority and has responsibility for serving the indigent sick of the counties of Fulton and DeKalb, from which counties it receives tax support. The types of clinics range from general practice to subspecialty. We would plan to begin the television program in one general clinic (probably Walk-In) and one specialty clinic (probably Cardiology); evaluate the programs in those clinics; and expand, on the basis of that experience, into other outpatient services.

2. Approach Suggested

We have not yet finalized specific plans of approach. This will be done through a committee of hospital and medical school staff established for this purpose. However, our present thinking is along these lines:

a. Run standard commercial programming from the three major local TV stations and preempt their commercials with health messages.

b. Run standard commercial programming from the three major local TV stations and insert 30-minute health programs at intervals.

c. Run continuous health programming in specialty clinics with disease-specific patient populations.

D. Assessment of Human and Technical Resources

1. Human and Technical Resources Required

This program will require television monitors, cameras, recorders, and production equipment. Human resources required will include program coordination, production, engineering, script writing, and filming.

2. Human and Technical Resources Available.

Section H describes the capability of Emory University School of Medicine's television service located at Grady Memorial Hospital. While this system is intended for use primarily in staff education, some sharing of equipment and technical expertise could be expected.

In addition, the hospital medical school staff contains the clinical knowledge necessary for determining contents of the television programs.

E. Assessment of Financial Resources Available

The Emory University television system described above was developed through a grant from the Georgia Regional Medical Program and is funded through that program and through subscription of member hospitals and other health providers.

To date, the hospital has received a gift of four color television monitors and four recorders from the private sector. We anticipate several other small gifts of this nature.

The hospital is funding the position of coordinator for the patient education television effort.

F. Assessment of Financial Resources Required

Funding for equipment:

- Color cameras (existing equipment is black and white)
- Television monitors and recorders

Funding for personnel:

- Development of content, script writing, production, filming, editing
- Managing equipment stationed in patient waiting rooms
- Evaluation of program effectiveness.

G. Program Evaluation

We recognize that program evaluation will be difficult since the television programming will constitute only one of the components in the overall patient education program of the hospital. It will, therefore, be impossible to precisely separate the variables, since we expect to be upgrading all components of the patient education program simultaneously. At the same time, the need for evaluation is clear. We must try to learn which approaches to patient education are most effective. Statistical validity of the evaluation process might be highest using a trained outside team, employing standard sampling and interviewing techniques. We have found that much of our internal evaluation is biased to a high degree by patients telling us what they think we want to hear.

H. Emory University School of Medicine

Emory University School of Medicine has equipment and personnel required for live broadcasts 8 hours a day over a microwave system covering an area approximately the size of Greater Atlanta and some of its closest suburbs. This capability is for black/white television only. The broadcasts originate from Station KVI-65, operating on four channels. The production for these live broadcasts originates from the auditorium of Grady Memorial Hospital.

We have two cameras in the auditorium, two in the studio, and two on standby. We have a modern control panel. The programs are taped on a VR-660 Ampex videotape recorder and the studio productions on a TR-60 videotape recorder. We have two quads for editing purposes. At the moment we have a staff composed of a director-producer, a chief engineer, three cameramen, a projectionist, and a secretary. The TR-60's have color capability. At present we have no color cameras.

Recently, equipment has been added so all of our library tapes can be dubbed into 3/4 inch cassettes suitable for Sony and other equipment. As rapidly as the demand is great enough, we are producing Sony cassettes for distribution from the Regional Medical Library. At the moment all new productions are dubbed into 1 inch Ampex tape and 3/4 inch cassettes.

I. Comparison of Grady With Other Hospitals Having Similar Needs

There are 89 hospitals similar to Grady in the U.S. that have outpatient clinic visits of 100,000 or more per year; 14 in the Southeast. The 100,000 annual outpatient visits was chosen in consultation with Mr. Robert Parrish, Administrator, Outpatient Department, Grady Memorial Hospital. Mr. Parrish felt this minimum represented a hospital that could effeciently utilize the educational materials and support the continuous operation of video communication equipment in its transmission.

Grady's outpatient visits of 375,320 during the 1970-71 academic year ranks it third in the Southeast and tenth in the U.S. out of the 89 hospitals. Ochsener Foundation Hospital in New Orleans was first in the Southeast with

1970-71 visits of 393,666. Los Angeles County Hospital was first in the nation with 687,732.

Total outpatient clinic visits in the U.S. at 87 of the 89 hospitals was 16,984,637 in 1970-71 (two hospitals in Puerto Rico were excluded from this tally). Total visits in the 14 Southeastern hospitals (12 states) was 2,787,220 in 1970-71.