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REPORT TO THE CENTRAL MICHIGAN EDUCATIONAL RESOURCES COUNCIL ON THE FEASIBILITY OF AN INTERCONNECTED TELECOMMUNICATION SYSTEM FOR THE 39 COUNTY REGION OF MICHIGAN.

CENTRAL MICHIGAN EDUCATIONAL RESOURCES COUNCIL
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THIS REPORT EXAMINES THE FEASIBILITY OF ELECTRONICALLY CONNECTING NORTHERN AND CENTRAL MICHIGAN AREA SCHOOLS FOR DATA PROCESSING AND FOR INSTRUCTIONAL, ADMINISTRATIVE, INFORMATION, AND AUDIO SERVICES. DATA GATHERED THROUGH QUESTIONNAIRES, DISCUSSIONS, WORKSHOPS, AND VISITATIONS DEMONSTRATE THE GENERAL DESIRE FOR PARTICIPATION IN AN INSTRUCTIONAL TV SYSTEM WITH A WIDE RANGE OF CLASSROOM COUSES. THE SYSTEM WOULD BE SUPPORTED BY FEDERAL, STATE , AND LOCAL FUNDS. WORKSHOP PROPOSALS FOR TYPES OF ELECTRONIC EQUIPMENT NEEDED AND THEIR COSTS ARE DISCUSSED. PROJECTIONS ARE MADE FOR THE NUMBER OF BROADCAST STATIONS NEEDED (SEVEN, ULTIMATELY), FOR THE AUDIO AND AURAL BROADCAST AND COMMUNICATION SERVICES REQUIRED, AND FOR THE CONTRACTING AND SHARED USE OF COMPUTER SERVICES. APPENDICES INCLUDE QUESTIONNAIRE RESULTS, DESCRIPTIONS OF PRESENT EDUCATIONAL RESOURCES COUNCIL PROGRAMS AND OF THE SCHOOL ELECTRONICS PLANNING EXERCISE (SEPEX), AND DISCUSSION OF THE FOLLOWING IN CONNECTION WITH THE PROPOSED SYSTEM--EDUCATIONAL REQUIREMENTS, OPEN-CIRCUIT TELEVISION SERVICE, COLOR TELEVISION, AND TYPICAL COSTS. (JO)

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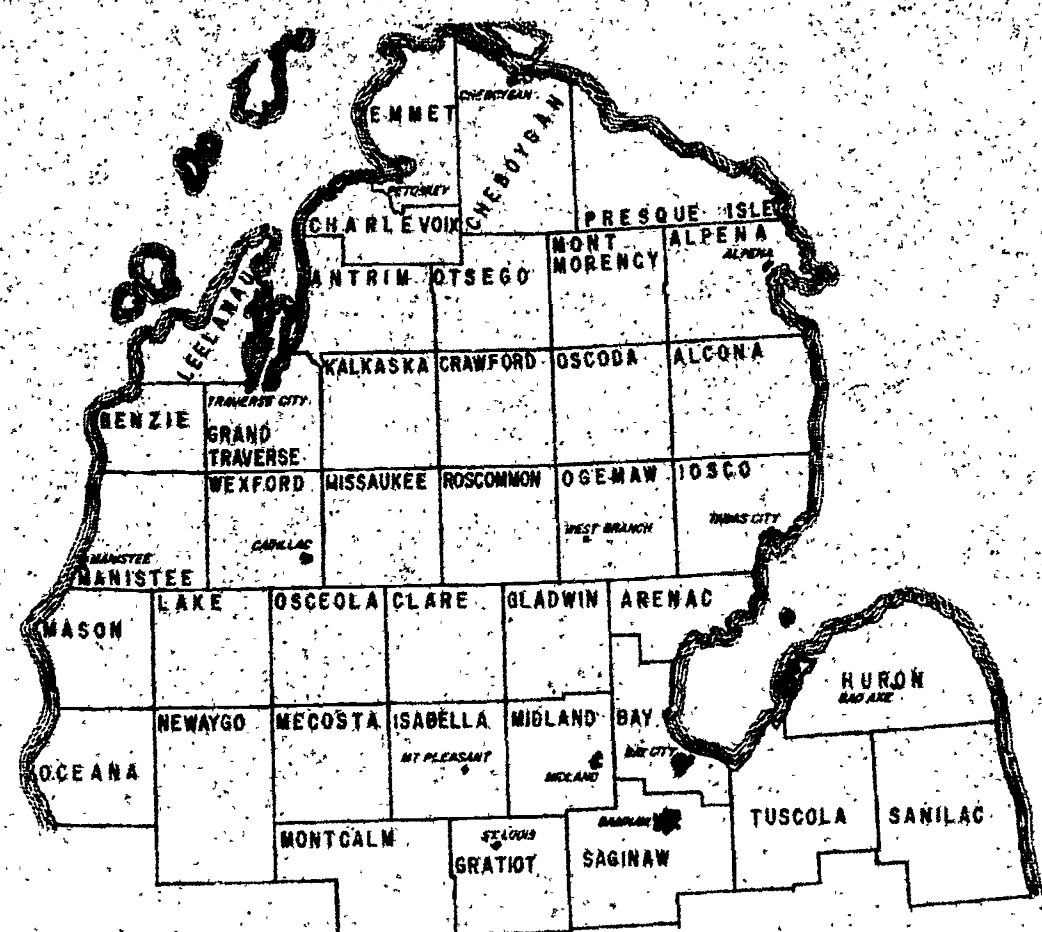

JUNE 30, 1967

JANSKY AND BAILEY
BROADCAST-TELEVISION DEPARTMENT
ATLANTIC RESEARCH CORPORATION
WASHINGTON, D.C.

REPORT TO THE CENTRAL MICHIGAN EDUCATIONAL RESOURCES COUNCIL ON THE FEASIBILITY OF AN INTERCONNECTED TELECOMMUNICATION SYSTEM FOR THE 39 COUNTY REGION OF MICHIGAN

June 30, 1967

Feasibility Study Director
James A. Matteson

Engineering - Jansky & Bailey
Roger E. Peterson

CENTRAL MICHIGAN *Educational Resources* COUNCIL

ntral Michigan University
Mt. Pleasant, Michigan
Phone 517–774-3211

June 30, 1967

Mr. Charles B. Park, Secretary
Central Michigan Educational Resources Council
Central Michigan University
Mount Pleasant, Michigan 48858

Dear Mr. Park:

Transmitted herewith is the final report to the Central Michigan Educational Resources Council acting as the agency of the 39 county Feasibility Study to Determine the Technical Feasibility of Interconnecting School Districts in Large Geographic Areas of Low Population Density by Electronic means for the Provision of Instructional and Administrative Services.

The Study includes the Technical Engineering report of Jansky and Bailey and the Administrative report of the Director under the Provision of the Federal Grant No. OE6-16-003 of the Department of Health, Education and Welfare.

Respectfully submitted,

James A Matteson

James A. Matteson, Director
39 County Feasibility Study
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PREFACE

Schools must lay the ground work, kindle the curiosity, provide the skills, and create the incentive that motivates continued learning year after year. If society is to meet and solve the problems faced today, school systems must become active, not passive -- innovative, not imitative. They must enlist and utilize the full educational potential of the entire community. A truly affluent society in which each citizen is not only permitted but encouraged to develop his potentialities to their fullest realization will be built only through more active participation of the entire citizenry -- teachers, administators, parents, and young people themselves. The acceptance of electronic means of communications as a vital tool is essential to accelerate and implement the desired objectives of our rapidly changing world. The social and educational patterns latent in automation are those of self-employment and artistic autonomy. Electronics is a means of immediacy.

INTRODUCTION

This report presents the results of a study to determine the technical feasibility of interconnecting School Districts in large geographic areas of low population density by electronic means for the provision of instructional and administrative services.

E.T.V. has been researched extensively. Instructional television is an educational tool whose basic effectiveness has been proven. No attempt will be made to further prove the value of E.T.V. in this study. Rather, this study is concerned with improving educational and administrative services through the use of electronic means. The educational opportunities afforded pupils in low population, rural areas are often limited due to the fact that their school cannot afford many of the educational services that are available to urban school districts. To acquire those same services, the rural school systems have many times found it advantageous to cooperatively underwrite their costs. The validity of the idea of a regionally supported resources, or educational communications center has been demonstrated in research such as that at Plainview, N. Y., under N.D.E.A., Title VII B, Contract No. O.E. 3-16-042. In addition, the idea of a regional center is supported and possible financing is available, under Title III of P.L. 89-10, the Elementary-Secondary Education Act of 1965.

The results of this study are a composite of the efforts of many people, especially the Central Michigan Educational Resources Council and its executive committee, and Mr. Lew Rhodes for his envision of the Study while he was Administrative Director of the Council. Invaluable service was given by Mr. Charles B. Park, Secretary of the Council and Director of Special Studies at Central Michigan University. Mr. Leslie Morford, Director of the Council, gave valuable suggestions and participated in several visitations. The School Administrators of the 39 counties cooperated with keen interest to add to the success of the study. A special thanks to the many professors at C.M.U. for the many informal discussions pertaining to the improvement of education.

The technical portion was done by the Broadcast-Television Department of Jansky & Bailey, Electronic Engineers of Washington, D.C. Mr. Roger Peterson represented his company. It was a privilege and a great pleasure to work with him. His contributions both technically and educationally were invaluable.

James Matteson

Director, Feasibility Study

BACKGROUND TO THE PROBLEM

The northern portion of Michigan's lower peninsula was originally settled because of its large stands of timber. When the logging boom ended, this area was left with few attributes to attract population.

Because of the poor soil for agriculture most communities in this region have turned towards tourism, services, pulp wood cutting, and small industry as their chief sources of employment. The human resources of this area have drifted towards the more urban areas of the state, and therefore the population in these small communities has not kept pace with the increase in population throughout the state. In spite of the growth in tourism and in the service industries, real family income in the area lags behind state and national averages. Two-thirds of the counties have over fifty percent of their households with incomes of less than $4,000.

One of the results of this declining economy is that educational opportunities in the smaller communities have lagged behind that of the nation and of the state. There has been increased pressure on the communities to consolidate school districts and offer their youth a durriculum which will make them more able to compete, but not even these consolidations have been able to completely solve the problems arising from the imbalance of educational opportunities between these northern counties and the more urban areas of the state.

Educational leaders in this northern area, however, have never accepted this situation as a permanent one. There has been a continuing history in this region of school joining together to cooperatively provide the services that they individually could not acquire. Examples of these cooperative ventures include:

The Central Michigan School Administrators Research Association: an organization of school administrators and board members who undertake cooperative research studies in the areas of school administration and finance.

The North Central Michigan Cooperative Agreement for College Admissions: an organization of high school counselors and college admissions officers who work together to bring high school curriculum standards closer to college admission requirements.

The Northern Michigan School Boards Association: which meets four times a year to stay abreast of current legislation and new ideas in education.

Additionally, several school systems cooperate in supporting in-service courses, not only for teachers, but also for other staff members such as school bus drivers and food handlers.

Probably the most notable example of cooperative services has been the Central Michigan Educational Television Council. This organization of schools began initially with a grant from the Fund for the Advancement of Education in 1959. It has provided services to its member schools by developing and producing instructional television courses for re-broadcast via commercial television stations throughout the area.

Considering the limited amount of time available from these stations, one hour each day on each station, the growth of the Council and its services has been remarkable. From 6,000 students in eleven school systems utilizing three television courses over two stations in 1959, the Council in the past six years has grown to serve 185,000 viewing pupils in close to 200 public and parochial schools with sixteen courses broadcast through the facilities of four commerical stations.

The success of this cooperatively operated organization not only in producing televssion courses, but also in the areas of cooperative curriculum planning and in-service teacher education, has provided the main impetus for the study that is proposed in the following pages..

Additional impetus has been provided, however, by certain problems that the E.T.V. Council will face in the immediate future. For the

1967-68 school year one commercial station has refused to either give or allow the Council to purchase broadcast time. Another has reduced the amount of time available for the courses. Most stations have notified the schools that this is the last year that broadcast time will be made available for school programs. The schools in this northern and central area, therefore, will have a cutback in service during the 1967-68 school year, and will face a complete loss the following year. Many of these systems have built their curricula around the basic core of instruction that has been provided in Science (five grade levels); Art (six grade levels); Music (five grade levels); and high school American History, Government, and Economics.

The search for a substitute, more flexible means of transmission has resulted in several actions in recent months that add additional facets to the problem.

With the advent of the recently passed Elementary-Secondary Education Act (P.L. 89-10), the educational leaders in this area quickly realized the potential of Title III for the provision of supplemental services throughout the region. On June 22, 1965, two meetings were held relative to action under this Title. The results of these meetings were that a new organization, the Central Michigan Educational Resources Council, was created and given instructions to make applications under PL 89-10, Title III for funds to create and operate a regional, cooperative Supplementary Education Center. In addition, the group was directed to undertake an investigation of the feasibility of interconnecting the schools in this northern and central Michigan area via electronic means for the provision of supplemental instructional services, administrative services, data processing, information storage, and audio services.

E.T.V. TODAY

Educational televison is now a teenager. In April it was 14 years old. During this brief period of time on the educational scene, it has grown rapidly from one ETV station in 1952 to 110 at the present time. If one adds to this an additional 600 (plus) closed circuit televison installations in educational institutions and at least a dozen more 2500 megacycle microwave operations, E.T.V.'s growth rate has been nothing short of phenomenal.

The following observations formed from current literature are presented to give an objective picture of E.T.V. today. Many expectations of E.T.V. have been accomplished. Current happenings have been presented in the classroom as they appeared. The good teacher has been shared through E.T.V. by many thousands and has brought excellent resources to classrooms which otherwise would have been denied. Production centers provide a training ground for fine arts, speech, acting, script writing and T.V. production. In the science area E.T.V. has demonstrated its ability to magnify objects for the individual benefit of each student.

Greater cooperation is needed to accomplish community action problem solving programs. Another area E.T.V. should improve in is for children during out-of school-hours. The sharing of the best in one area with others needs to be expanded.

Some things E.T.V. has not done is to provide excellent education at less cost, or to solve the teacher shortage and classroom needs.

E.T.V. has given unexpected benefits in the areas of teamwork of staff members and other professionals, better organization of subject presentation, limited resources, individualized work, and aided in helping homebound or hospitalized students.

Most of the difficulties seem to be in scheduling, interaction and feed-back, and the fear that T.V. will standardize curriculum eliminating local teacher initiative. The schools effectively using I.T.V.

have been able to eliminate these so-called obstacles.

The growing interest in E.T.V. in the Nation offers a bright future. The improvement in the quality of programs and the technological advances offer unlimited flexibility to the classrooms.

CENTRAL MICHIGAN EDUCATIONAL RESOURCE COUNCIL

In 1959, 11 school districts and Central Michigan University formed the Central Michigan Educational Televison Council to advance the use of this educational media in 40 counties. Their charter spelled out four objectives:

--To provide, through cooperative study and financial support, a program of educaional television for the schools in the area served.

--To provide enrichment and some part of the direct instruction to the schools served.

--To provide exploration, experimentation, and evaluation in the use of educational televison.

--To provide pre-service and in-service opportunities for training teachers in the techniques of originating, receiving, and using televised lessons.

With a three year grant, and broadcast time donated by commercial televison stations in central and northern Michigan, the Council began operation. There were three television courses offered in the first school year, to approximate 6,000 viewing students.

In the fall of 1967, the Council enters its ninth year. During the 1966-67 school year, the Council produced and offered Art and Music for lower and upper elementary students, Science for middle and upper elementary and junior high, American History for junior and senior high school and Michigan Conservation.

In addition, the Council rented for use by its member schools courses in Michigan Social Studies, Art for upper elementary, Modern Math and World Understanding.

Cost of operation is financed by a per-pupil membership fee from the participating schools. Several of theCouncil-produced series have been rented to other instructional television units.

In addition to the course offerings, the Council provides teacher guide materials, in-service teacher utilization workshops, curriculum workshops, consultant help in classroom organizational or technical problems relating to ITV use.

The Council is unique in that it is completely school-organized and controlled. There is no direction from either the University or the commercial stations. Recently the Council voted to widen its functions to include the cooperative sharing of other educational resources; and correspondingly its name changed to the Central Michigan Educational Resources Council.

In addition to the long range goals outlined in this Feasibility Study, the Council meanwhile stives to improve the educational quality of the lessons, to develop closer contact with the students and teachers it serves and to seek expanded utilization in its service area.

The Council is deeply indebted to the commercial stations for providing broadcast time for the 1966-67 school year. The following commercial stations participated:

Channel 12, WJRT-TV, Flint
Channel 9, WWTV, Cadillac
Channel 10, WWUP-TV, Sault Ste. Marie
Channel 7, WPBN-TV, Traverse City
Channel 4, WTOM-TV, Cheboygan

E.T.V. IN THE 39-COUNTY AREA

Since 1959 the Central Michigan Educational Resources Council, with studios at Central Michigan University, has produced and provided council schools with ITV lessons. In 1959, Channel 12 in Flint and Channel 5 in Saginaw gave one hour of commercial time to the Council. In 1963, Channel 5 discontinued this service. The Council was fortunate in securing the services of Channels 4, 7, and 9-10. At the present time Channel 12 will continue for one more year with 30 minutes. Channels 4, 7, and 9-10 have also agreed to continue. In addition to the channels mentioned, the Council purchases time from Channel 19 (Delta College) and also exchanges programs with Channel 10 (Jackson). Channel 14 (Central Michigan University) is cooperating; however, the limited coverage provides very little additional coverage.

In addition to the restricted air time and the coverage area it is essential to explore the possibility of covering the area with an interconnecting communications system. In gathering data for the Study, the following needs were established by questionnaire, group discussion, workshops, and visitation.

DATA - QUESTIONNAIRE[1]

114 Public School Districts Responding
72 Non-Public Schools Responding

The questionnaire indicated 40 percent of the school districts of the 39 counties are using Instructional Television. The Tri-county area of Midland, Bay, and Saginaw utilized Channel 12 (Flint) and 19 (Delta College - Saginaw). One county school system at Alpena is presently employing 2500 MC and CCTV to serve their schools with ITV, utilizing programs on tape. With the present means of using commercial time, only two-thirds[2] of the school districts in the 39 counties are receiving a quality signal for ITV programs. This point becomes important considering that 90 percent of the school districts responding desire participation in ITV.[3]

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1 See Appendix A
2 See Appendix B
3 See Appendix A, page 2

The data strongly supports ITV for supplemental instruction on a regular basis. In addition to ITV, the school districts indicated an extensive interest in other types and capabilities of electronics[4] which can be accomplished by a total systems program of inter-connecting school districts.

The curriculum data in the K-6 area indicates a strong interest in using ITV for Vocal Music, Art, Arithmetic, Elementary Science, Geography, History, Remedial Reading, and Foreign Languages.

The Junior High interest in using ITV is strong in the areas of History, General Sciences, Math, Foreign Languages, Art and Geography.

The High School response includes a large selction of subjects to be offered by ITV. The subject areas with strong interest are Civics, History--American and World, Art, and Biology.

The information and data collected for the report substantiated previous reports that television in the future will be used extensivley at all levels of education. The several group meetings with Superintendents enthusiastically supported quality ITV capability. Distribution of the signal within the district would be the individual school district's responsibility.

It should be noted that in the discussions the capabilities of a quality signal was very important to the school district. The interest of the school districts in establishing an inter-connecting communications system. This recognizes the need for Federal, State and local funding in the establishment of such a system.

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4 See Appendix A, page 3

WORKSHOPS[5]

One technique employed in gathering data for this report was the workshop approach. On March 21, 1967, forty-five people representing the 39 counties and the Council participated. The main purpose was to inform the participants of the types and cost of hardware used in electronic communications. The second step was to play roles of decision-making people representative of the 39-county area. The third step was to formulate a plan for the utilization of a system of communications interconnecting the school districts. The full description is in Appendix C. After seven hours of enthusiastic participation, the members of each of three teams assembled to report each plan and vote on the best plan. The results of the best plan was a consensus of all three.

In the hypothetical exercise the "A" Plan[6] calls for an expenditure of $3,800,000 for Teletype, TV Receivers, Computers, Retrieval System, Broadcast TV, and Personnel. The group expressed sizeable savings over conventional means.

The "B" group expressed a much more conservative plan of $646,000 including Teletype, Facsimile, Retrieval Sustem, Computer Service, Video Recorders, and Broadcast TV. The group incorporated the savings in the utilization of more efficient use of personnel.

The "C" group extended services and included teaching techniques of para-professionals in multi-group classes. Their total was $2,413,000 which included Electrowriter, Telelecture, Computer, Closed Circuit TV and Broadcast TV. This group had a more ambitious program than is reflected in the cost. For example, the utilization of computer service and broadcast TV pro-rated over the total area reflected a savings of several hundred

5 See Appendix C
6 See Appendix D

thousands of dollars. They defended their plan suggesting even greater amounts could be saved by employing advanced techniques and more efficient use of personnel and equipment.

The final assembly of all three groups after one hour of open debate of plans resulted in a unanimous agreement on the use of Teletype, Computers for Administrative Data Processing, Video Tape Recorders, TV Receivers, and Broadcast ETV by interconnecting school districts with electronic communications.

Three additional area workshops were held. Three counties in each of these three workshops represented one of the above mentioned plans. In these workshops the Superintendents and Board Members developed plans for their area. One other condition differed in that the game description and basic hardware information was given to the participants two weeks prior to the meeting. The results were basically the same. The major difference being that of a greater concern for their area. In summary discussion with the participants, the broader area of coverage was quickly recognized as a solution to reduce total cost. The recognition of individual school district lines was erased immediatley when the opportunity for improvement of education could be obtained through cooperation. This is strongly supported by the related studies in the 39-county areas.

RELATED STUDIES

The North Central Michigan Polaris-Apollo Study involved the ten countries of Alcona, Clare, Crawford, Gadwin, Iosco, Missaukee, Ogemaw, Oscoda, Roscommon and Wexford. The Polaris-Apollo Study undertook extensive study of educational needs of the ten counties. The direct services to the area include Data Processing, Research and Evaluation, Public Relations and Publishing, Program Design and Consultant Service, Liaison and Arbitration in addition to Supplementary Educational Curriculum Service. The cooperative effort these counties demonstrate is the willingness to disregard individual school district lines for improvement of educational services. It also illustrates the feasibility of inter-connecting large areas with electronic communications.

The Traverse Bay Five-County Processing Study further points out the need for areas grouping together to improve services.

The Tri-County Study of Bay-Arenac and Iosco is to establish professional services in guidance and counseling including testing, and psychological services.

The Seven County Study of Manistee, Mason, Lake, Mecosta, Osceola, Wexford and Missaukee to determine their cultural needs gives more evidence to support the willingness to cooperate to improve educational opportunities.

There are other studies in the 39-county area which reflect the desire to improve education through cooperative efforts.

Since these studies are being completed at the present time or were completed very recently, they add timely support to the Council Study. We are greatly appreciative of the information available. The implementation of the above mentioned studies would coordinate especially well with the inter-connecting of school districts by an electronics system.

The Administrative Service capabilities[7] of electronic communications include accounting -- payroll, inventory, budgets, cost projection, scheduling of classes and report cards to mention a few. The efficiency of time and cost in utilizing electronic capabilities for administrative services was supported enthusiastically by the workshop participants, especially as an additional service through a total systems plan[8] of inter-connecting school districts electronically.

The area meetings and workshops provided evidence of a concern for improving curriculum and administrative services. A great deal of enthusiasm was expressed by both Public and Non-Public School People about the

7 See Appendix E

8 See Appendix E

possibility of utilizing electronic systems through inter-connecting districts. The desire to use Broadcast TV was strongly supported to increase course offering and to aid schools in the area of teacher shortages. The interest in administrative services was exceptionally high in all areas, especially considering a network system could include all capabilities of electronic uses.

The general trend developed from the questionnaire, workshops, and area meetings clearly supports a network system for the 39 counties.

TELECOMMUNICATIONS SYSTEMS AND EQUIPMENTS

The Central Michigan Educational Resources Council has a wide selection of technical equipment and system services to help administer, teach, and broaden the total educational horizon within the 39-county area. Each is discussed here in the general context of services as well as specific hardware. Frequently the terminal hardware items are only a small part of the total system cost. The major costs are usually: (1) The interconnecting facilities that are required to tie the local school or institution to a central distributing point having access to the total educational communications media, and (2) the preparation of the program or information prior to its distribution. It is not intended to imply at this point that the 39-county area should use any specific service, but rather we are showing here the tremendous latitude and variety of telecommunications services that are available to assist all levels of education.

VOICE GRADE COMMUNICATIONS

The connection of two locations with a voice grade telephone type circuit permits a wide variety of services and equipments to be utilized. In addition to being able to talk between two locations, such as a conventional telephone conversation, it may be used for remote lecturing, teleprinters, a variety of electronic writers, facsimile, and most share time computer connections.

Recent years have demonstrated the versatility of the voice grade communications line. One use of long standing is facsimile. This technique has been in use for many years to provide pictures of newspaper quality for distances of thousands of miles. These pictures are transmitted at a slow speed, usually at a rate of 1 per minute or less. Recent variations of facsimile has been slow scan television and long distance Xerography. The techniques are very similar except that a hard or paper copy is produced with facsimile and Xerography whereas a soft or destructible copy is produced by slow scan television.

A recent technique, Computer Assisted Instruction, provides a close coordination between the student and a specially programmed time share computer. A number of students can utilize the same computer on a time sharing basis without noticeable delay by any user.

Data and computer interconnection service, through a special terminal device (Data-Phone), utilize the regular telephone company dial system to gain access to specially programmed time share central computers. By this technique a user in a particular location may dial a long distance call on his Data-Phone to the desired computer, and by prearranged coding, utilize his teletype machine to gain access to his special data files and to utilize the computer in the solving of particular problems. These problems may range from inventory control, to grade and transcript exchange for students. The technique offers a great deal of versatility since the actual long distance phone call is relatively inexpensive (less than a dollar in late evening hours) with only the additional charges of the data set, and the actual computer time.

The teletypewriter and its other related punched tape services are available under trade names such as TWX, Teletype, and Telex depending on the manufacturer and supplier. All of these devices start with a conventional typewriter keyboard and upon its activation, transmit an electrical signal to a distant typewriter to provide a written or typed message. Many variations of this device are possible including the casual typing of the information onto a punched paper tape for later transmission at a steady high speed to a remote typewriter. Of course, instead of verbally talking to another person, the operator is exchanging written communications which are printed out on the teletypewriter.

Variations can be added to the teletypewriter such as its coupling to computer interfaces so that instead of talking to another person, the operator is questioning a special time sharing computer and requesting it to provide an answer. Obviously there must be a common language between the sender and the receiver. To query a computer in the wrong language can only result in a wrong answer. Most computers require at least a modified abbreviated type of English language in order to utilize them with a teletypewriter. However, this language is easily understood and learned by nontechnical personnel.

Voice grade communication circuits permit several communications to be incorporated within them to provide a hybrid type service such as "Blackboard by Wire," whereby an electronic writer is coupled with a spoken lecture. Thus the student not only hears the instructor lecturing, but sees his blackboard notes on a projected screen image at one or more remote classrooms.

The electronic writer is sold under several trade names including the Victor Electrowriter and the Concord Interwriter. These devices essentially translate the motions of a handwritten message into electrical signals that are transmitted to the receiving point where they are reconstructed into a similar note. Thus symbols and handwriting characteristics are easily transmitted even though they are of a special nature. Variations include the presentation of this display on an overhead projector so that an entire class can see the writing of an instructor many miles away.

WIDE BAND AND TELEVISION SYSTEMS

For the Central Michigan Educational Resources Council, wide band programming is likely to be confined to various aspects of television and its related use to classroom instruction. This is not to discount its adaptation sometime in the future to other usage but this appears to be the most prominent and valuable part of this type of communication.

By use of the televison screen we can overcome barriers of time and distance imposed on our sense of sight and hearing. By viewing the screen we can see what is happening around us some distance away at locations normally invisible to us without television. Television can bring to our sight events from the past; televised events of yesterday can be repeated again and again to aid our imperfect memories. The use of television in the educational process is growing rapidly and its potential seemingly hardly scratched.

The problem facing the Central M chigan Region is first to main tain the instructional usage already developed in the classrooms of the region and up to now, distributed by commerical television stations. The stations are reluctant to commit further daytime hours, beyond the 1967-68 school year, and an alternate must be found if the area schools are to continue this type of television service. Second, the area must expand and improve its television service to include all schools, private and public, wishing to utilize the instructional material of the Council. Third, the programming should be such that educational cultural enrichment type programs canbe supplied to the home viewer to broaden his exposure to the world today. A broadcast type educational television system can achieve a solution to all of these problems.

Educational televison broadcast stations are frequently called open circuit channel stations. With such an open system, virtually every-one may gain direct benefit from its operation - the family, the student, the business man, the professional man, the farmer, the government agency, and the school system may partake of the general educational programs such a system can bring to them. Specialized television course material can be directed to specific groups using special closed circuit techniques where such programming would not be accessible to the general public. The physical laws of science provide us with only frequency spectrum capable of division into a limited number of channels when we broadcast into the air, such as with conventional television stations. However, many frequency spectrums can be used simultaneously if each can be kept confined to a special coaxial cable or route so that the various spectrums do not interfere with each other. When educational and instructional material if of such quatity as to require more than one program to be distributed within the 39 county area at the same time, closed circuit channels are the methods by which this distribution can be achieved.

There are two general methods by which television channels can be confined to a closed or limited circuit. The first puts the conventional television channel into a special coaxial cable instead of broadcasting it into the air. Then, only those television receivers actually connected to the special cable can receive the television program. If the cable is extended throughout a building, campus, or even a whole community, every TV set connected to it would be able to receive the channels that are put on the cable. Television receivers not connected to the cable could not receive these channels and would in fact be completely unaware that such channels were being transmitted. The cable method of closed distribution is commonly called Cable or Closed Circuit and is typical of the technique used by Community Antenna Television (CATV) operators.

The second means of confining television to a closed channel is to use extremely high (microwave) frequencies that begin to resemble light in their ability to be focused into a narrow beam. These frequencies are far above those used for regular televison channels and therefore cannot be received by conventional television receivers.

With microwave transmission, the channels are confined in the sense that special receivers are required and the signals are beamed from one point to another. Only those special microwave receivers in the direct line of sight of the microwave transmitter can receive these closed channels. Microwave transmission is the most economical method of distributing several television channels over distances of 25 miles and up as much as 3000 miles. Although microwave paths for transmission are usually limited to line of sight distances (20 to 30 miles) many such individual paths may be hooked together in chain fashion to achieve a long path.

The Federal Communications Commission has established a special service for instructional purposes in the microwave region called Instructional Television Fixed Service (ITFS). This service, although similar to microwave in the frequency range, can be used in somewhat the same manner as broadcast TV stations with the exception that it is not receivable by home television sets. Thus the ITFS technique is basically a closed distribution technique suitable for local school district usage where economic factors permit.

The development of a broadcast open circuit system throughout the 39 county area must include means for distributing television programming from a central distribution point to the individual transmitters throughout the region. Microwave is the most reliable and effective way of accomplishing this distribution. Because it is broadcast and must be of high reliability, considerable care should be exercised in the design and routing of the microwave system. During hours of nonuse by the broadcast stations the microwave system can be utilized for other services such as instructional television and similar related services ona closed circuit basis. Thus the initial microwave distribution system for broadcast may be utilized off-hours for other purposes of a closed circuit nature.

Consideration of television must include the need for improved programming and program producing facilities. At present there are studios at Mt. Pleasant (Central Michigan Universtiy) and Bay City (Delta College). Neither of these studios are used anywhere near to their capacity. We believe considerable effort should be made to become more efficient in the production of programming so that a minimum of man power is expended for each hour of instructional programming and that equipments and staffs are used efficietnly without undue waiting times between program production. Some additions to equipments may be desirable such as more video tape recorders to enable the on-air program of several stations to run without interference to the production of new programs within the studios. The present studio capacity appears adequate for the foreseeable future in this region but the development of local program facilities at the school district level, such as now being undertaken in Alpena, should be encouraged and expanded to permit genreration oflocal expressson and the development of resources within individual school districts. As a matter of operational procedures however, virtually all programming should be coordinated with the Council that is to be used throughout the area. A program that might be orginated in Alpena or Bay City would be played for on-air programming at a central point which at this time appears most logically to be the Central Michigan studios. Other distribution points could be utilized, but from an economic standpoint it appears unwise to develop more facilities of this nature until the present ones are used more nearly to capacity.

RECOMMENDATIONS TO THE CENTRAL MICHIGAN EDUCATIONAL RESOURCES COUNCIL

1. It is recommended that the Council fulfill its responsibilities to the Lower Peninsula 39 County region by providing leadership in the development of a plan which will provide support to the state agencies (i.e., the Legislature, the State Board of Education, and the State Department of Education), that must assume the obligation of implementing the plans which are defined in this study as well as in the State Study.

2. It is recommended that the Council support the establishment of a state authority for a state-wide educational communications system which will include the 39 northern counties encompassed by the Council under its jurisdiction.

3. This Study is intended to be compatible and complementary to the proposed state-wide system detailed in the concurrent State Study.

General Recommendations for Service

Recommendations of service made in this section are grouped into three categories. Each category can be developed individually or collectively in any combination desired. Many inter-relationships between the three services are likely and very careful development must be achieved so that all portions of the system are compatible with each other. The three categories are television, audio or voice communications, and data. Each service is considered here individually, but where certain economics or unique inter-relationships are evident, these are mentioned also.

TELEVISION

The Central Michigan Educational Resources Council should develop a system of broadcast TV stations to cover the 39 county area. In the long term, 7 or more broadcast stations may be required. Initially, however, the present two stations at Mt. Pleasant and Saginaw - Bay City must be supplemented immediately with two additional high power stations in the upper portions of the state. One would be located near Alpena, utilizing the reserved Channel 6 assigned to Alpena. The second new transmitter should be between Traverse City and Cadillac utilizing the presently reserved Channel 27 of Cadillac. These two stations will extend the broadcast ETV service in the upper parts of the region so that most of the schools now utilizing the television programming of the Council can continue school service when the commercial stations in the area discontinue their ETV programming sometime after the 1967-1968 year.

A microwave interconnection system must be provided concurrent with the addition of these two stations to provide programs to them from the central distribution point at Mt. Pleasant, Michigan. A two way microwave system should be included between Central Michigan University and Delta College for program origination and interconnection of these stations. The microwave system should be routed in such manner as to permit additional stations for this region to be added later without rerouting the microwave system.

The second stage of development should have the Channel 14 Mt.

Pleasant transmitter increased in height and power and moved 10 miles to the west. The tower structure should increase its antenna height to at least 1000 ft. above average terrain and the transmitter size should be increased to at least the 30 kw size.

Channel 19 at Delta College cannot raise its antenna at its present site. Aeronautical approaches to Midland Airport restrict the antenna height to that now existing. As part of Stage three, this station must have additional height and power for area service thus necessitating a move, probably to the east or southeast in order to avoid aeronautical hazard.The tower should be at least 1000 feet high and the transmitter at least a 30 kw size.

Completion of the broadcast service in the center peninsula will require stations at Manistee and Bad Axe. These stations should be at least 200 kw effective power with towers of at least 500 ft. in height. Service from these stations begin to be supplemental in nature. Therefore their exact parameters and locations would be subject to later re-evaluation in terms of the existing coverage already provided.

It is conceivable that three additional stations may be desired in the future development. These could be at Traverse City, West Branch, and Petoskey. It is not known at this time the extent of broadcast service desired in these communities. There are TV channels available for use by noncommercial licensees and their use is suggested as a future step in the completion of the ETV system.

As part of the television system recommendations, the present studios at Mt. Pleasant (Central Michigan University) and Saginaw (Delta College) probably will suffice for the foreseeable future for most program productions. However both need some further equipment additions to permit full time operation of the network of stations with instructional programming and educational broadcasting. Most needed are 3 or 4 quadruplex tape recorders, monitoring, and switching equipment for a regional distribution center at Mt. Pleasant. This equipment would be utilized for "on air" programming of the network system. It should be a rare occasion that any program would go on "live from the studios." Normally programs would be recorded on video tape for playing on the schedule required by the schools. In this way programs may be repeated as necessary to accommodate conflicting bell schedules or to provide repeat courses at a later time of the year.

Cost details for the TV Broadcast System and Development are in Appendix F and a summary schedule is on page F-13.

Instructional Television Fixed Service

The Alpena Public Schools are authorized by the FCC to use the ITF service for local distribution. The efforts of Alpena to utilize this new service are commendable and should be encouraged. We stress the need, however, for an awareness of the limitations, problems, virtues, costs, and probable evolutionary changes that are a part of this service. It cannot cover long distances or wide areas; present equipments are still marginal in performance; costs vary widely with specific installations and rather drastic changes in the FCC rules for allocation are likely. Equipment investments should be kept reasonable with careful attention given to system performance.

The Lower Peninsula area may, in time, require more than one simultaneous television program channel. This time, however, appears to be some years away. Therefore, the ITF service is considered of secondary importance to this region. The location of the various broadcast transmitters with their substantial towers will provide effective stepping stones for adding the ITF service when it is needed. It may be necessary to add more microwave channel and possibly some additional studio production capability in the local school districts. Whatever the final development of instructional TV service may be in the Lower Peninsula Region, the broadcast station is the most effective starting point and provides many excellent ITF transmitter points and relay interconnection facilities when needed.

Community Antenna Television System

There are several community antenna television systems (CATV) in the 39 county area. These are concentrated primarily in and around Traverse City, Petoskey, Alpena, and Oscoda. Systems are proposed in Manistee and Cadillac. This report recommends that all CATV systems be encouraged to provide ETV service to the local schools. Ideally, two or more channels would be desirable within a few years. At least one channel should be fulltime for at least 18 hours per day, 7 days a week. The other channel(s) would be more for in-school hours. Careful attention should be given when dealing with the CATV systems so that the service and quality of performance provided is in keeping with the recommendations of Appendix M of this report. Most new CATV systems or those that have been recently rebuilt provide quality service. However, there are still many older systems that, not only cannot provide acceptable color transmission, their technical performance is even below minimal black and white requirements. Marginal or inadequate quality of service should not be tolerated or condoned to any school even if it is free.

Voice Communications

Most voice type communications are of a two way nature. This is illustrated by the telephone whereby both caller and receiver must be able to originate spoken information as well as listen. For this reason most voice communications circuits cannot use radio broadcast service which is basically one way. With this restriction, audio service will, in general, be relegated to leasing wire communications from common carriers such as the telephone company. Where five or more voice channels are required between two given points, savings can be achieved by bulk rate purchases of service (such as the Telpak rates). The state already has several Telpak routes through the Lower Peninsula and is known to be planning an extension to Alpena as soon as practical. Combining local, regional, and state requirements for telephone line rentals is recommended.

In general, audio service would be restricted to voice grade quality such as provided on a standard telephone. If higher quality is needed, wider bandwidths can be leased but at rather sharply increased costs.

FM Radio

An aural broadcast service should be provided through a relay of FM radio stations throughout the Lower Peninsula area although only a moderate interest has been expressed for such a service. An FM broadcast service could provide not only a primary FM radio service to the area but could provide up to four additional specialized broadcast services simultaneously to the area via Subsidiary Communications Authorizations. These are one-way, good quality voice circuits that are possible via multiplex subcarriers on the conventional FM station. These SCA subcarriers can be used for specialized data transmission and station control, provided it is directly related to either on going instruction material carried on the main channel, or related to the operation of the station or its programming.

FM radio service can provide a one-way service for high quality audio with the provision for auxiliary channels as mentioned above. If an FM radio service is incorporated in the 39 county area after the television microwave system has been established it is very easy to piggy-back the high-quality music type audio channel on the television relay system. The FM transmitter and antenna can use the same building and tower of a TV station and thereby achieve considerable savings in cost. Typical cost data is given in Appendix I.

Data Services

Data services today are tending to the leasing of time on large central time share computers. The user has a standard teletype writer machine and a voice grade telephone line to the central computer which stores and processes the information and returns the results to the user's teletypewriter. The leased time service is normally most versatile and expedient because usage is charged on a strict time and distance basis with a set minimum just like a long distance telephone call. The investment in facilities and equipment is kept to an absolute minimum. If in the future the need arises for a number of data circuits to a time-share computer, either bulk rates or a local computer might be economically feasible. For the immediate future, however, the telephone line rental to a time share computer is probably the most economic. A computer has a tremendous appetite and capability for digesting, processing, and storing information. It takes many users operating 12-18 hours a day to justify the cost of a major computer.

This report recommends the contracting of computer services for use by the schools on a case by case basis, utilizing either leased private telephone lines, TWX service, or Dataphone and the standard long distance dial telephone system. Each user of a share time computer program must have careful studies made to determine the type of computer and the programming best suited to meet his specific needs. Mt. Clemens (Macomb County Intermediate School District) has applied for a computer system under Title III of P. L. 89-10. It is sufficient to say here that each case should be studied individually by people knowledgeable in the field of computers and computer programming. It could well be that a time share computer located even as far away as Chicago could be of economic value to individual schools and school districts in the 39 county area. The cost would be for the computer time, the long distance calls, and the terminal equipment rental. Usage up to 10 hours per month costs in the range of $500.

The time share computer appears to be the most logical answer for the small user, at least for the foreseeable future. The reason is simply economic. The bigger and faster the computer, the cheaper it makes each computation. As a result it is far cheaper to build one large computer and operate it full time with thousands of customers, than to have thousands of small inadequate computers, one for each user (who may use it only a few hours a month).

A later development in the use of computers might be the introduction of Computer Assisted Instruction whereby students actually use share time computers and special computer programs to speed the learning process in certain subjects. Such programs and techniques are still in much the experimental stage, but as their usage and development progresses, there seems to be a great deal of promise in such machines and their usage.

APPENDIX A

QUESTIONNAIRE RESULTS

APPENDIX A

QUESTIONNAIRE RESULTS

1. Total number of questionnaires returned. Public - 114 Non-public - 77

2. Are you presently using any television broadcasts in your school system?

Public - Yes	52	Non-public - Yes	58
No	61	No	16

3. Is there a broadcast signal available in your area presently?

Public - Yes	101	Non-public - Yes	51
No	7	No	6

4. Has your Board of Education expressed interest in educational television?

Public - Yes	89	Non-public - Yes	51
No	21	No	9

5. Have you or members of your staff observed ETV?

Public - Yes	106	Non-public - Yes	73
No	8	No	?

6. Does your school system have television sets available in any classrooms?

Public - Yes	86	Non-public - Yes	63
No	28	No	12

7. In your opinion, how could ETV of any kind be best put to use in your school system?

	Public	Non-Public
a. Total instruction of specific subjects	15	24
b. Supplemental instruction of specific subjects	100	56
c. For selected students only	14	1
d. For all students	36	47
e. For accelerated students	26	3
f. For special events only	13	2
g. On regularly scheduled basis	55	55
h. For large enrollment classes	23	6
i. Regular size classes	35	36
j. Small enrollment classes	13	2
k. Audio-visual aid distribution	29	15

8. Have you ever had a demonstration or observed circuit television for your school system?

Public - Yes	43	Non-Public - Yes	11
No	70	No	61

9. What areas other than ETV do you see as a use for electronics? See next sheet.

10. Would you be willing to share a meeting with your board members, other members of your administrative staff and teaching staff to receive information about electronic communication?

Public -	Yes	101	Non-public - Yes	49
	No	7	No	13

APPENDIX

QUESTIONNAIRE RESULTS (continued)

9. What areas other than ETV do you see as a use for electronics?

Data Processing (13)
Scheduling (6)
Testing
School Accounting (3)
Record Keeping (2)
Test Scoring
Individual Instruction
Purchasing
Educational Radio (4)
Programmed Learning
Data Storage
Film Projection
Computer Assisted Instruction
Video Tape
Records
Research
Tel., Ved., A. V., CIA
Coaxial Cable for Communication
Basic Electricity
Payrolls, Financial Accounting
E. D. P.
Payroll (4)
Machines, Mechanisms for Language Labs
Science Area
Recordings & Tapes for Lessons in Phonetics and Foreign Languages
Electronic Classroom for Reading Laboratory & a Language Laboratory.
In-Service Training
Curriculum Study
Tapes
Experimentation in Computerized Education
Classes by Tape Recording
Library Reference Material
Vocational
Data-Processing - Vocational
Clerical Help
Closed Circuit Between County Schools
Computational Use
Instruction
Audio - Visual Centers (Library Materials)
Communication Between Buildings
Information Retrieval
Radio Controlled Transportation
Materials & Resources
Computors
Administration
Parental Information (PTA)
Evalulation

APPENDIX A

QUESTIONNAIRE RESULTS (continued)

Communication between ETV Instructor
and Student

Scoring Standardized Tests

FM Radio (Festival of Sound)

CAL, CAI

Inter-School Communication

ELEMENTARY: K-6

SUBJECT AREA	OFFERED		RECOMMENDED FOR BROADCAST TV	
	Public		Non-Public	
Arts:			7	4
Music	52	59	11	27
Vocal	72	40	25	18
Instrumental	74	11	5	2
Fine and Practical Arts	54	39	29	17
Arithmetic:	86	63	21	17
English Studies:	1	0	5	1
Reading	91	59	11	8
Language	90	59	14	11
Spelling	90	58	6	3
Writing	91	57	6	8
Health and Physical Education	78	49	14	13
Social Studies:	0	0	8	10
Elementary Science	94	67	45	44
Geography	92	62	43	29
History	90	59	39	33
Special Education	54	4	6	0
Foreign Languages	31	4	22	14

Others not listed: * indicates those which were added most often

- Library*
- Guidance*
- Remedial Reading*
- Religion* (by Non-Public)
- Games
- Foreign Language (Recommended)
- Literature
- Speech
- Speech Correction
- Art
- Civics
- French
- Vocational Education
- Michigan Conservation
- Social Problems
- Testing

JUNIOR HIGH SCHOOL - 7-9, 7-8

SUBJECT AREA	OFFERED		RECOMMENDED FOR BROADCAST TV	
	Public		Non-Public	
Required Subjects:				
History	91	57	54	42
English	90	51	19	12
General Science	89	55	53	45
Math	89	52	30	19
Physical Education	86	31	8	5
Elected Courses:				
Art	50	31	33	26
Foreign Language	31	4	26	13
General Business	31	3	10	2
Geography	51	24	32	18
Home Economics	56	3	12	2
Industrial Arts	63	9	7	2
Music	61	29	18	19
Others:				
Guidance	38	6	5	7
Exploritory Courses	10	1	4	1

Others: Required	Elected	Others
Reading	Vocational Education	Library
Geography	Social Science	Guidance
Vocal Music	Typing	Remedial Reading
Industrial Arts	Drama	Individual Tutoring
Home Economics	Recent American History	Power Mechanics
Biology	Elementary Electricity	Religion (by Non-Public)
Government	Vocal Music	Intermediate Typing
Michigan History	Arts & Crafts	
Spelling	Remedial Reading	
Arts & Crafts	Speech	
Civics	Michigan History	
Literature	Journalism	

JUNIOR HIGH SCHOOL - 7-9, 7-8

OTHERS: Required	Elected	Others
Experimental Home Economics, Music, Industrial Arts, Art	Household Maintenance	
	World Understanding	
	History	
	Industrial Arts	
Art	Algebra	
French		
Instrumental Music		

HIGH SCHOOL - 9-12, 10-12

SUBJECT AREA	OFFERED		RECOMMENDED FOR BROADCAST TV	
	Public		Non-Public	
Required Courses:				
Civics	83	9	31	6
English	84	10	16	6
History:	0	0	14	0
American	87	9	30	8
World	66	10	25	6
Literature	74	10	17	4
Physical Education	67	6	3	1
Elected Courses:				
Art	58	3	17	2
Business Education	75	6	6	2
Foreign Language:	1	0	8	0
French	45	4	10	2
Spanish	44	2	15	1
Latin	29	6	7	2
German	16	1	8	1
Home Economics	81	3	6	0
Industrial Arts	75	2	4	0
Mathematics:	0	0	5	0
Algebra	85	10	14	5
Geometry	85	9	14	5
Trigonometry	79	4	12	2
Music:	0	0	4	0
Vocal	69	14	15	3
Band	75	3	4	1
Instrumental	49	1	1	0
Science:	0	0	7	0
Biology	85	8	19	6
Chemistry	84	8	12	4
Physics	83	6	15	3
Physical Science	65	5	14	4
Guidance	58	5	2	0
Testing	52	4	1	0

HIGH SCHOOL - 9-12, 10-12

Others not listed: *indicates those which were added most often

Required	Elected	Others
Home Economics	Russian	General Science
Shop	Chinese	Speech*
Biology*	Japanese	Auto Mechanics
General Science*		Electronics
Algebra*		Building Trades
General Math*		Drafting
Economics*		Hospitality Services
American Government		Library
Driver's Training		Geography*
Michigan History		World History
Orientation		Continental History*
Religion (by Non-Public)		Agriculture*
		Sociology
		Reading Improvement
		Journalism
		Refresher Arithmetic

APPENDIX B

PRESENT BROADCAST TV SERVICE OF

COUNCIL PROGRAMS

APPENDIX B

PRESENT BROADCAST TV SERVICE OF COUNCIL PROGRAMS

WWUP-TV, CHANNEL 10 -
SAULT STE. MARIE

Modern Math 6
Michigan Social Studies 3 or 4
World Understanding 6
Art 5 or 6
Music 3 - 4

WTOM-TV, CHANNEL 4 -
CHEBOYGAN

Science 4
Science 5 - 6
Art 1 - 2
Art 3 - 4
Music 1 - 2
Michigan Conservation

WPBN-TV, CHANNEL 7 -
TRAVERSE CITY

Science 4
Science 5 - 6
Art 1 - 2
Art 3 - 4
Music 1 - 2
Michigan Conservation

WWTV, CHANNEL 9 -
CADILLAC

Modern Math 6
Michigan Social Studies 3 or 4
World Understanding 6
Art 5 - 6
Music 3 - 4

WUCM-TV, CHANNEL 19 -
DELTA COLLEGE

Michigan Social Studies 3 or 4
Art 5 or 6
Music 3 - 4

WJRT, CHANNEL 12 -
FLINT

U.S. History 8 - 11
Science 4
Science 5 - 6
Science 7 - 8
Art 1 - 2
Art 3 - 4
Music 1 - 2
Michigan Conservation

WCMU-TV, CHANNEL 14 -
MT. PLEASANT

U.S. History 8 - 11
Science 4
Science 5 - 6
Science 7 - 8
Art 1 - 2
Art 3 - 4
Music 1 - 2
Michigan Conservation

WZZM-TV, CHANNEL 13 -
GRAND RAPIDS

Modern Math 6
Art 5 or 6
Michigan Social Studies 3 or 4
Music 3 - 4
World Understanding 6

WMSB-TV, CHANNEL 10 -
LANSING

Modern Math 6
Art 5 or 6
Michigan Social Studies 3 or 4
Music 3 - 4
World Understanding 6

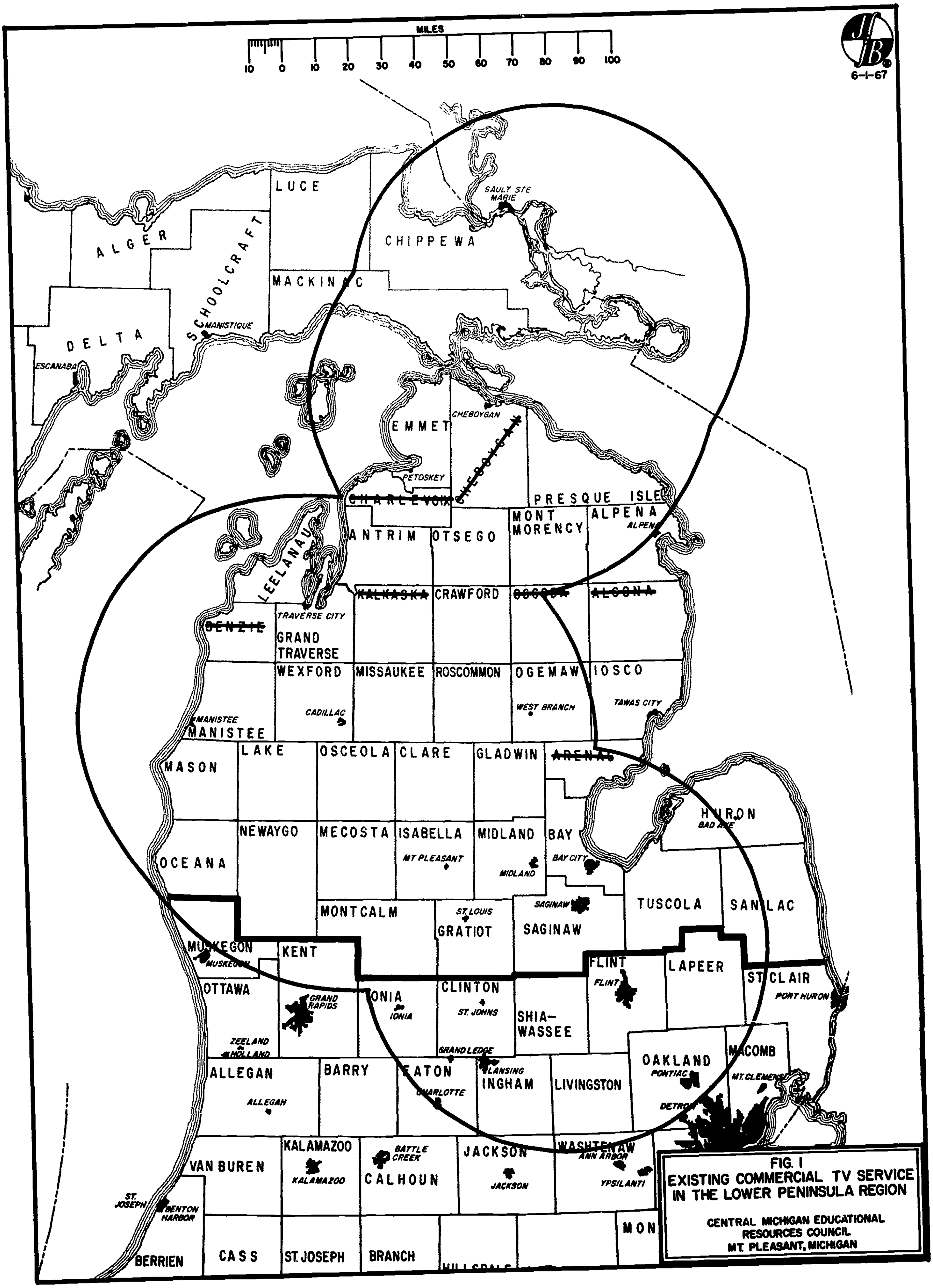

FIG. I
EXISTING COMMERCIAL TV SERVICE
IN THE LOWER PENINSULA REGION

CENTRAL MICHIGAN EDUCATIONAL
RESOURCES COUNCIL
MT. PLEASANT, MICHIGAN

APPENDIX C

SEPEX

APPENDIX C

ABT ASSOCIATES, INC.
55 Wheeler Street
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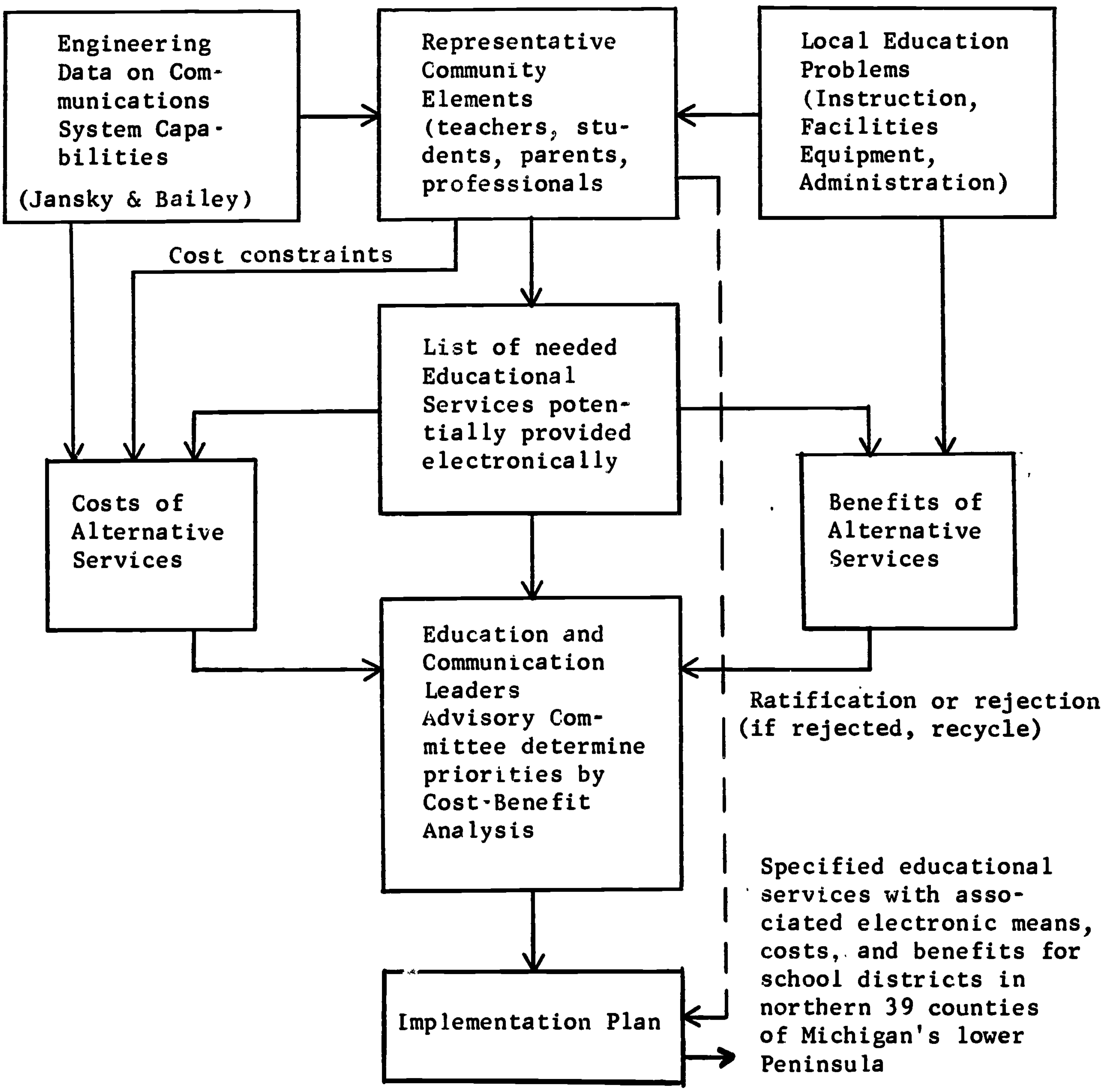
Central Michigan Educational Resources Council



PLANNING PROCESS FOR INTER-CONNECTING SCHOOL DISTRICTS IN LARGE GEOGRAPHIC AREAS OF LOW POPULATION DENSITY BY ELECTRONIC MEANS FOR THE PROVISION OF INSTRUCTIONAL AND ADMINISTRATIVE SERVICES

APPENDIX C

SEPEX

a School Electronics Planning Exercise
prepared for CMERC
by Abt Associates Inc.

March 1967

Description of the Game

The SEPEX game is designed to involve educational decision makers in the process of planning applications of electronic systems to instructional and administrative educational services. The game employs innovative simulation and role playing techniques to motivate and create understanding of the feasibility, potential educational benefits and costs of alternative electronic systems for inter-connecting school districts in large geographic areas of low population density. As a simulated planning process, it induces the participants to consider how current educational services could be provided more efficiently by the aid of electronic means; what future services are desirable and feasible using these new technological developments; and how cooperatively provided electronic services may aid in increasing and equalizing educational opportunities.

Setting of the Game: The game simulates the partly cooperative, partly competitive educational planning activities of three adjacent county school districts in the Onrush Peninsula Area of the north-central state of Nagitchmi.

The Players: The fifty to sixty players are distributed among three roughly equal teams, each team representing important educational roles and interests in each of three adjacent county school districts. Depending on the particular characteristics of the county school districts, the players have local interests as well as functional educational objectives. Each of the three county district teams are initially organized into a planning committee (superintendent and school board) and four requirements subcommittees for curriculum, teacher, facilities, and administrative needs (these use the remaining team members).

The three county district teams (described in more detail in the Scenario and County District Descriptions) are:

Bay County (richest, most popular, industrialized)

Farmfield County (well off, dispersed farming population)

Woodland County (economically depressed lumber/fishing area, sparsely populated)

There are twelve roles for players, distributed among the three teams in the following way:

Sequence of Activities:

1. Each of the three teams is given its educational problems in the form of planning requirements subcommittee reports on present and future teacher needs, curriculum needs, facilities and equipment needs. The planning requirements subcommittees are staffed by the players simulating the consumers of education: Teachers, students, parents, farmers, businessmen, professionals, and unions.

2. Each team is given a technological menu of electronic communications display, storage and retrieval, and processing hardware with associated capabilities and costs.

3. School boards and superintendents of each county match education requirements with the hardware menu, while considering costs and tradeoffs, make cost-benefit comparisons of alternatives.

4. Using previous steps, school boards and superintendents form a priority list of allegedly most efficient hardware combinations (systems) meeting the education system requirements.

5. Planning groups obtain approval of own teams by power point-weighted vote of all team members.

6. Three teams negotiate with each other to attempt coordinated implementation.

7. One or more coordinated cross-county plans (over 2 or 3 counties) are formulated.

8. Entire 50 players vote on alternative plans -- if all are rejected return to step 5 -- if that fails, to step 4.

9. If one or more plans pass plenary vote, they are scored for highest educational cost-effectiveness and maximum utilization of electronic technology.

SEPEX
(School Electronics Planning Exercise)

SCENARIO

Abt Associates Inc.
March 1967

The state of Nagitchmi, known as the "Moosehead state," is one of the north central groups of the U.S.A. It consists of the Onrush Peninsula bounted by Lake Onrush on the north, east, and west, and Lower Nagitchmi immediately south of the Peninsula. The state is 25th in size with an area of 54,321 square miles, of which 1001 square miles are inland lakes. The name of the state derives from one of the old Indian tribes of the region, the Nagichimacs, transformed by the pest-ridden early settlers into Nagitchmi.

The Onrush Peninsula comprising the northern part of the state consists of rugged wooded hills (Woodland County) and fertile coastal plain (Farmfield and Bay Counties).

The population of the Peninsula is approximately 1,000,000 (about 1/5 of the state's). Bay County is located on the southeast part of the peninsula. Bay County's manufacturing cities of Bayview, Wanigas, and Centerville, give it the leading county population of about 500,000. Farmfield County, as the name implies, thrives on dairy and mixed farming in the central area. Farmfield County has a population of approximately 300,000. Woodland County in the north of the Peninsula is most sparsely populated with about 200,000 inhabitants. The population has been growing at about 2% annually in Bay County, 1% annually in Farmfield County, and has remained relatively constant in Woodland County. The average population per household in the Peninsula has declined from 3.6 in 1950 to 3.4 in 1960.

The government of the State of Nagitchmi consists of a governor and a unicameral legislature. The governor and state superintendent of public instruction are elected for a two-year term. The legislature consists of a senate of 100 members, elected to terms of two years from each district. Local government is by county and municipal government.

Education

Nagitchmi has pioneered in what has become the typical U.S. pattern of free, tax-supported and state-controlled schools. Local control through elected school district boards was a feature borrowed from New England, but the state superintendent of public instruction as the elective head of the system was a novel adaptation from European ministries of education. County School commissioners were added later, as was a state board of education responsible for state teachers' colleges and issuance of teachers' licenses and certificates acting chiefly through the state superintendent. There are approximately 10 school districts--a great decline from nearly 70 earlier in the century resulting from consolidation prompted by efficiency considerations.

(There are three school districts in the Onrush Peninsula, corresponding to the three counties.)

The executives of the county school districts are county school superintendents, paid by the state. The superintendents are appointed by the elected county school boards.

Enrollment in the public schools in the Onrush Peninsula is approximately 300,000 or 87% of the school census (ages 5 - 19). Of course, 200,000 were in elementary grades (K - 6) and 100,000 in secondary (7 - 12).

The total public school expenditures for the school year for the state was $400,000,000, of which some $50,000,000 went to 10,000 teachers. Average expense per attending pupil in the state was $300 and the average teacher's salary in the state was $5,500. The average expense per attending pupil in the Onrush Peninsula was only $200, however, and the average teacher's salary in the Peninsula was only $5,000. This lag behind the more industrialized southern part of the state is a source of chagrin and aspiration for the Peninsula educators.

Parochial schools (Catholic, Lutheran, and others) accounted for about one-third of the above enrollments.

Economy

The prosperous manufacturing centers of Bay County and rich farmlands of Farmfield County present a constrast to the relatively depressed lumbering, fishing, and tourist industries of Woodland County. Woodland County educators have sought help from their adjacent county colleagues in improving the employability of their students through a variety of enrichment, counseling, and vocational programs, but little progress has been made to date. The more conservative policies of the Farmfield County school board have inhibited the necessary expenditures, while Bay County has its own serious problems of a growing school population and technological unemployment.

Politics and Public Opinion

The state has been typically middle-of-the-road in its national political preferences, with a somewhat more conservative leaning in the farm areas in local politics. Bay County industrial towns are the source of moderately progressive attitudes. The press in all three counties reflects rather than forms the predominant public opinion in favor of good education for all coupled with reduced taxes. Innovations in favor of education are welcomed when they do not cost money or trespass on cherished religious beliefs or cultural mores. Nevertheless, many thoughtful citizens, liberal and conservative alike, in all three Peninsula counties are becoming increasingly concerned over the lag in the quality of education offered Peninsula students behind the rest of the state and the needs of the future. Some of the better informed educators have argued for the introduction of modern electronics communications, processing, and display equipment to increase the efficiency of instruction and administration in the schools, and this has become the outstanding current education issue in the state.

Committees have been formed in all three Peninsula counties to consider current and future needs for teachers, curricula, facilities, and administration so that the potential uses of electronic communications, monitoring, displaying, processing, storing, and retrieval equipment can be evaluated.

6-1-67

MAP OF ONRUSH PENINSULA AND IT'S THREE COUNTIES

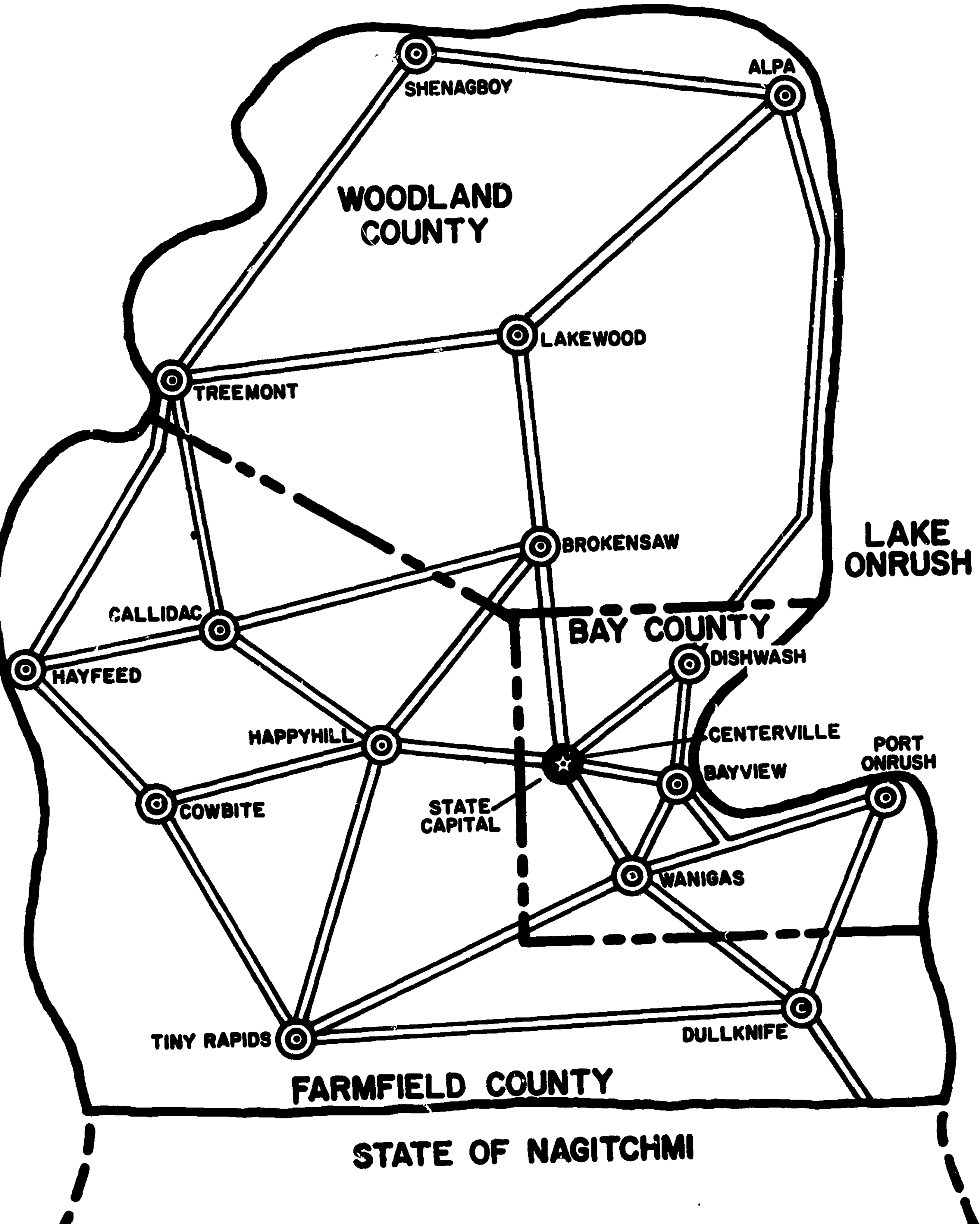


FIG. 2

2

SEPEX

Technological Menu with Costs

	Terminal Equipment Costs			Transmission Load
(Hard Copy)	Teletype	$ 500		10 per phone line
(Hard Copy)	Electrowriter	300		10 " " "
	Telelecture	2,000		1 " " "
(Hard Copy)	Facsimile	1,500		1 " " "
	Videofile	2,000		1 " " "
	Slow Scan TV	1,500		1 " " "
	TV Receiver	200		" " "
	CAI/PI Computer	3,000,000	($850,000/ yr. rental)	1 " microwave link or TV broadcast channel or phone lines, no. depending on no. of consoles.
	Administrative Computer (scheduling, payroll, records)	600,000	($150,000 / yr. rental)	
	Videotape (TV) Recorder	1,500		
	Dataphone		50/month	
	Closed Circuit TV		500/room	

Transmission Costs

(Based on average distance of 100 miles and 12 hour/day use)

Private Phone Line: $\$2/\text{mile/month} \times \frac{12}{24} \times 100 \text{ miles} = \$100/\text{mo./school}$

(for shared lines, divide cost per sharer by number of sharers, but also divide capacity per sharer by number sharing.)

Private Microwave Link: $20/mile/month/TV channel

Broadcast TV: $500,000/year for 10 years

Sample Computation:

Problem: Compute cost of teletype network linking 300 schools to one central facility with 10 teletypes/school, plus broadcast TV with 40 receivers/school for all 300 schools.

Teletype: 3,000 teletype sets x $500 = $1,500,000
+ 300 phone lines @ $100/mo. x 12 = $360,000 yr. rental

TV: One transmitter @ $500,000/yr. = $500,000 yr. rental
40 x 300 receivers @ $200 each = $2,400,000

= 1,500,000 + 2,400,000 = $3,900,000 initial cost

+ 360,000 + 500,000 = $860,000 annual rental costs

Facilities @ $20/square foot.

Personnel:	Teachers:	$6,000 - $10,000 per year
	Computer Programmer:	$10,000 per year
	Equipment Trainer:	$10,000 per year

Communications Hardware	For Instruction									For Administration						
	Lect	Disc	Group Proj	Indiv Proj	Sim	Game	Lab	Libry Res	Home Proj	Curric Plan	Sched	Grading	Record	Eval	Costing	Acctng
A. Slow scan TV	x	x	x		x	x	x				x		x			
B. Electrowriting	x	x	x			x			x	x	x			x		
C. Teletype			x	x	x	x	x	x		x	x	x	x	x	x	x
D. Telelecture	x		x	x	x	x			x	x	x					
E. Dataphone		x	x	x		x		x	x	x	x			x	x	x
F. Facsimile			x					x		x	x				x	
G. CAI				x	x	x				x	x					
H. Videofile	x	x	x	x			x	x		x	x		x	x		x
A + B	x	x	x		x				x	x				x		
A + C			x	x	x	x	x	x		x	x	x	x	x	x	x
A + D	x		x	x	x	x			x	x	x			x		
A + G				x	x	x				x	x					
B + E	x	x	x	x		x		x	x	x	x			x		
B + F		x	x			x		x	x	x	x			x	x	x
B + G	x	x	x	x	x	x			x	x	x			x		
C + G			x	x	x	x	x	x		x	x	x	x	x	x	x
A + H	x	x	x	x	x	x	x	x		x	x		x	x		x
B + H	x	x	x	x		x	x	x	x	x	x		x	x		x
C + H	x	x	x	x	x	x	x	x		x	x	x	x	x	x	x
D + H	x	x	x	x	x	x	x			x	x		x	x		x

CMERC

Issues in Educational Electronic Communication
For Planning Exercise

1. Desired additional educational (instructional and administrative) services made feasible by the use of electronic communications equipment.

2. Desired applications of electronic equipment to improvement of existing educational services.

3. Desired location of additional and improved educational services and functions.

4. Desired using population of new and improved educational services.

5. Desired control over new and improved educational services, with respect to administration, programming, development, evaluation, and cost accounting.

6. Desired schedule of implementation of improvements.

7. Time utilization-scheduling (time-sharing, etc.)

8. Financing of the improvements.

Interested Parties

Students	1, 2, 3, 4, 5
Parents	1, 2, 3, 4, 5, 6, 7
Teachers	1, 2, 3, 4, 5, 6
Administrators	1, 2, 3, 4, 5, 6, 7
Local Government	3, 4, 5, 6, 7
Public Opinion	1, 2, 3, 4, 5, 6, 7

CMERC

Instructional Innovations Rendered Feasible Or More Efficient By Electronic Communications

School as Community Center

Team Teaching (Part of Team Supplied Electronically)

Programmed Instruction

Specialized Studies in Depth

Special Vocational Training

Independent Individual or Small Group Study Projects

Inter-Class and Inter-School Simulations

Time-Shared Tutoring

<u>Administrative Innovations</u>

Computer Scheduling

Computer Storage, Statistical Summarization, and Retrieval of Records

Video Staff Conferences

Computer Payroll Accounting

Program Performance Evaluation Using Computer Cost-effectiveness Models

Computer Design of Individual Student Study Plans to Best Match the Student's Record

At One Central Location	At Many Decentralized (Local Remote) Locations
Videotape library	Audio and Video input/output
Film library	Teletype input/output
Slide library	Dataphone input/output
Programmed instruction library	CAI input/output
Switching computer	Videofile
Time-shared computer	Facsimile
Storage inputs	
Student records (duplicate?)	
Netting with national centers	
Scheduling programs	
Program editing facility	
Telelecture	
Slowscan TV	

Software Requirements

System Plan	Curriculum Plans
User Instructions	Lesson Plans
System Scheduling Plans	Local Scheduling Plans

CMERC

Electronics Applications By Subject

Language Arts

- Language labs
- Videotapes of dramas
- Telephone drill
- Drama/poetry/fiction library

Arithmetic

- Simulated problems
- Programmed instruction
- Graphic demonstrations
- Real world applications

Science

- TV live experiments
- Data library
- Industrial applications

Social Science

- TV live political events
- Data library
- Demographic visuals

Counseling

- TV display of student records
- Career alternatives
- Career simulations

SEPEX

Scenario and Subcommittees (Bay County)

Bay County, although the smallest of the three with respect to area, contains the largest percentage of population in the Onrush Peninsula. Unlike the other two counties, it is relatively urbanized, and faced with the problem of a more rapidly expanding population. Each year new commercial concerns are attracted to the area because of its geographic location and its low tax rate. This commercial influx has in turn attracted workers and their families, and the educational facilities have been unable to expand rapidly enough to accommodate them. With a current school enrollment of 150,000 (K through 12), and only 5000 teachers, the county's teacher-student ratio is lagging behind the desired state norm, and the annual population growth rate of 2% is threatening to lower that ratio even more.

Teachers in Bay County are becoming increasingly disturbed by the lack of facilities and the increased pressure created by the population growth. Over the past five years their unions have strengthened, and are applying pressure on the local school boards for a decreased work load and increased benefits. But the school board is hampered by its inability to hire a sufficient number of new teachers. The dropout rate in the teaching staff has been high, due to inducement from more favorable areas, resulting in a loss of from 200 - 500 teachers per year. Even without this high dropout rate, the school board would have to hire at least 100 additional teachers per year just to maintain the present low teacher-student ratio of 1:30.

One of the main teacher complaints--and one shared by the school administration as well--is the volume of paper work created by the large school age population. At least 15 hours of each teacher's week is spent in the mechanical function of recording grades and other student data. In addition, the urban character of the area produces a large flux in school-age population: one student may remain in the area only two years, to be replaced by two or three more short-term students. This creates administration headaches and volumes of paper work involved in maintaining records and providing transfer information.

Many of the schools in Bay County are hampered by a lack of space. Building construction is lengthy and expensive, and the school board has been unable to match facilities to the growing population. Not only is there a demand for buildings to house classrooms and offices. The current trend is toward increased facilities for guidance, physical education, extra-curricular activities, cultura events, and health clinics. More established and well-to-do families in the Bay County area are insisting that their children be provided with facilities to match those in other urban areas. But the flux in population in the industrializ areas, and the low tax returns from those areas, have been limiting the board's ability to provide all schools with increased facilities.

Because of the urban character of Bay County, it does contain a large cross-section of socio-economic groups, and each school is forced to maintain a curriculum to meet the demands of each of these groups. Increasing pressure has been felt to make the schools meet national standards for college entrance, but this requires that Bay County maintain good math, science, and language facilities in all of its schools. Laboratories and materials for this type of curriculum are costly, and good teachers are hard to come by. In addition to college entrance demands Bay County must maintain adequate vocational facilities to meet the demands of technological employment in the surrounding community. Unlike the students in the farming or woodland areas, Bay County students will have to be prepared during high school to perform skilled labor after graduation.

In order to evaluate possible solutions to these problems the County has organized four subcommittees. It will be the responsibility of these subcommitte to evaluate the various electronic systems available with respect to cost and effectiveness, keeping in mind the following educational and practical objectives

Teacher Subcommittee

1) Determine the most effective means of eliminating the mechanical functions imposed upon teachers by record keeping and transferring.

2) Find the most effective means of meeting the annual recruiting problem.

3) Eliminate or lower the high teacher dropout rate.

4) Improve the teacher:student ratio to meet desired state norm.

5) Supplement teachers or teaching methods to improve the quality of material available in Bay County Schools.

6) Provide for some method of in-service teacher training to keep up with modern educational methods.

Administrative Subcommittee

1) Determine the most effective means of eliminating the mechanical functions imposed upon administration by record keeping and transferrals.

2) Establish a more effective means of communication between schools and school districts.

3) Consider the idea of central student files for the district or the tri-county region to eliminate problem of transferring records.

4) Determine the desired degree of local autonomy and compare with the amount permitted by each electronic system.

Facilities and Equipment Subcommittee

1) Determine the most cost-effective way of meeting the shortage of supplementary and extra-curricular facilities.

2) Consider the installation of equipment (visual aids, shops, library materials) in one central location and the use of electronic equipment to make those facilities available to all schools.

Curriculum Subcommittee

1) Determine existing and projected curriculum needs in each subject area.

2) Determine teaching staff and/or electronic equipment most cost-effective to meet those needs.

3) Determine amount of curriculum scheduling necessary with each type of electronic system, or combination of systems.

4) Determine types and amounts of supplementary materials (texts, study guides, visual aids, lecture halls, etc.) required by each electronic system or combination of systems.

5) Determine which system or combination can meet the needs of the maximum number of schools and school systems.

During the first thirty minutes of the game, these subcommittees will meet to review the requirements of their county and make recommendations to the Planning Committee. Suggested membership in each subcommittee of the Bay County Planning Committee:

<u>Teacher Subcommittee</u>

1 School Board Member
1 Teacher
1 Parent
1 Legislator
1 Superintendent

<u>Administrative Subcommittee</u>

1 Superintendent
1 Press/Radio/TV
1 Teacher
1 Business/Professional Man

<u>Facilities & Equipment Subcommittee</u>

1 School Board Member
1 Union Representative
1 Busioness/Professional Man
1 Legislator
1 Farmer

<u>Curriculum Subcommittee</u>

1 School Board Member
1 Teacher
2 Students
1 Parent

SEPEX

Farmfield County Team Scenario

Farmfield County has a student population of 90,000 with only 3,000 teachers. The student/teacher ratio is therefore 30 to 1, which is in excess of the state average of 26 to 1. An immediate necessity is to either increase the number of teachers or improve teaching technology and hence the teaching efficiency of the teachers.

During the past thirty years, the marginal farmers have been leaving the land, thus enabling the consolidation of the land into large, efficient, modern farms. The median income in Farmfield County is therefore quite high. There is an adequate tax base to finance educational improvements. But because of the conservatism of the inhabitants, proposals for increased taxes for larger educational budgets have been consistently voted down.

Some members of the school committee have recently suggested that the high school science courses should be supplemented with instruction on modern farming techniques. It is argued that the sons of the large farmers usually go on to college where they study agriculture, and then return to their own farms. Supplementing the traditional science program would therefore help to prepare these students for college.

The teacher shortage has led some of the more concerned members of the community to urge for higher teacher salaries in order to induce additional teachers to come to Farmfield County.

As in this county the population is widely dispersed, a major problem is the selection of the most desirable locations for schools. Ideally, the schools should be located so that they minimize the travel distance for the greatest number of students. This wide dispersal of the population and the schools results also in administrative problems. It has been argued that Electronic Data Processing could eliminate many of the existing administrative problems.

In order to tackle these educational problems, Farmfield County has organized into four subcommittees: Curriculum, Teacher, Facilities and

Equipment, and Administrative. During the first thirty minutes of the game, these subcommittee will meet to review the requirements of their county and make recommendations to the Planning Committee. Each committee should consider, among others, the following topics.

Curriculum Subcommittee

1) Consider ways in which electronic communication systems can improve the quality of the education in Farmfield County.

2) Consider ways in which electronic communications systems could supplement the traditional science program in the secondary schools.

Teacher Subcommittee

1) Consider ways in which electronic communication systems can improve the efficiency of teaching.

2) Consider the feasibility of hiring more teachers, to improve the teacher/student ratio, versus improving teaching efficiency by means of electronic systems.

Facilities and Equipment Subcommittee

1) Consider how electronic systems can be an important factor in determining the optimum locations for schools.

Administrative Subcommittee

1) Consider ways in which Electronic Data Processing could eliminate existing administrative problems which arise from the wide dispersal of the schools.

The players representing Farmfield County may be distributed amoung the committees in the following manner:

Curriculum Subcommittee

1 School Board Member

1 Teacher

1 Parent

1 Student

Teacher Subcommittee

1 School Board Member

1 Teacher

1 Parent

1 Farmer

Facilities and Equipment Subcommittee

1 School Board Member

1 Teacher

1 Businessman

Administrative Subcommittee

1 Farmer

1 Press/Radio/TV

1 Legislator

SEPEX

Woodland County Team Scenario

Woodland County is located at the upper half of the Onrush Peninsula. Major cities within the county are Alpa, Brokensaw, Lakewood, Shenagboy and Treeport. The region is noted for fine forests and lumber products. Annually thousands of tourists come from all parts of the United States to enjoy the unspoiled beauty of the virgin forests and lakes. The County's economy is dependent on the lumber industry and the tourist industry. There is also a small fishing industry at Treeport. In recent years the economy of the County has continually become more depressed as a result of the migration of the talented young people of the county to the larger city areas in the southern part of Nagitchmi to seek better employment opportunities. Thus, the cost of labor in the region has increased to such an extent that some of the lumber companies have been forced to move to other states in order to find lower operating costs. The relatively lower educational quality of the county has discouraged many industries from investing in the region in fear of the poor quality of the existing supply of labor.

Education in Woodland County has always been focused on providing the student with better employment opportunities. Of the County population of two-hundred thousand, 60,000 are students. The County's schools are currently staffed by 2000 teachers. The student/teacher ratio of 30/1 is far higher than the State average of 26.5/1. The school boards have always found it difficult to attract good teachers to the County because of low pay and relative lack of opportunity for advancement. Furthermore, the individual schools are relatively smaller compared to other schools in the state, thereby increasing the teaching load and also the troublesome administrative responsibilities for the individual teacher. Currently four committees have been established to study the problems of teachers, curriculum, facilities/equipment and administration of the local schools in light of modern educational electronic equipment in hopes of finding ways to improve the quality of education in the County. Following is a list of the committees, their membership and the areas which each committee should consider.

Curriculum Committee

Teacher School Board Member Student Union	1. Future curriculum needs. 2. Future teacher availability. 3. Future employment demands. 4. Higher Education. 5. How modern educational electronics equipment can compliment present curriculum thereby upgrading the quality of education.

The Curriculum Committee is basically interested in finding methods to improve the curriculum of the schools of Woodland County. The restraint on the Committee is the lack of funds to hire as many teachers as they would like, therefore the Committee is considering the possibility of connecting up with a Peninsula-wide educational television network which would make available more courses and materials for the students of Woodland County.

Teacher Committee

Superintendent School Board Member Parent (PTA leader)	1. Are current teacher/student ratios satisfactory? 2. Can additional teachers be hired? 3. How can Woodland County attract more teachers? 4. How can the quality of education be improved by using modern electronics equipment? 5. Will connection with state wide ETV improve the quality of teaching and also free the teacher to participate in more personal attention to individual students? 6. What are the relative costs of hiring better qualified teachers to meet the educational needs of the County as compared to using modern electronics equipment by hooking up with a state network?

This committee is primarily concerned with the quantity and quality of teachers available to Woodland County in the future. They feel that it is necessary to improve the current teacher ratio of 26.5/1. But they are very aware of the lack of funds in the county to finance the large numbers of teachers which must be hired in the next five to ten years. The Committee should explore the possibility of establishing either a peninsula network of electronic teaching aids, or hooking up with a statewide network.

Facilities/Equipment Committee

School Board Member
Legislator
Businessman
Press/Radio/TV

1. Future building needs of the schools in the County.
2. Increase in student population for the next ten years
3. Approximate building footage needed, approximate costs.
4. Financing of new school facilities.
5. Equipment costs of the proposed electronic equipments.
6. Type of space needed to handle equipment.
7. Maintenance personnel.

The Facilities/Equipment Committee is primarily interested in planning for the expected building and equipment needs of the schools in Woodland County. Members of this Committee should be cognizant of the changes which may have to be instituted because of the input of new electronics equipment. The Committee must plan for the increase in student population. The restraints on the Committee is a lack of financial funds with which to build and purchase with. The Committee is therefore somewhat reluctant to really go into endeavors which would involve heavy capital outlay.

Administrative Committee

Public School Superintendent
Teacher
Farmer

1. Current adminstrative burden on both administrators and teachers.
2. Expected increase in administrative responsibilities in the next ten years.
3. Data problems - storage and retrieval.
4. Methods whereby the administrative burdens can be relieved from a teacher thus allowing the teacher to have more time to plan curriculum, tutor talented or slow students, etc.
5. How can modern electronics equipment provide services necessary for more efficient administration of the County's schools.

The Administrative Committee is very concerned with the heavy routine administrative functions which the teachers are responsible for. It is the Committee's aim to examine the technology menu to determine ways whereby machines can better help the teacher and freeing the teacher for more important teaching functions. In addition, the Committee is concerned with the future administrative needs of the County, and how such hardware as computers can help in the problem of data processing. The Committee is cognizant of the costs of the new electronic equipment, but feel that with state support these programs can be successfully implemented. The Committee also believes that more efficient administration will attract more teachers to the Woodland County area. The current high labor costs involved in reviewing County-wide data and forms can be much alleviated by the use of computers, thus cutting down actual operating costs in the long run.

APPENDIX D

SEPEX

PROPOSED PLANS

APPENDIX D

SEPEX

PROPOSED PLANS

HARDWARE	BAY	FARMFIELD	WOODLAND
Teletype	+720,000 (310) 1,000,000	(6) 3,000	
Electrowriter			(10) 3,000
Telelecture			(240) 480,000
Facsimile		(7) 10,500	
Videofile		(6) 12,000 +14,000	
Slow Scan TV			
TV Receivers	(300) 150,000		(240) X
CAI/PI Computer			
Administ. Computer	(1) 350,000	(1) 150,000 3 +14,000	(1) 800,000 +150,000 +(75,000)
Video Recorder	(310) 465,000	(6) 9,000 +144,000	(240) 360,000
Dataphone			
Closed Circuit TV			(240) 120,000
Broadcast TV	(1) 250,000	(1) 500,000 3 +220,000	(1) 500,000 +(250,000)
Personnel	500,000		
TOTAL:	$3,820,000	$646,000	$2,413,000

APPENDIX E

EDUCATIONAL REQUIREMENTS

APPENDIX E

EDUCATIONAL REQUIREMENTS

Various types of communication lines are available to connect terminal educational hardware and machines to regional distribution points.

A. Narrow Band Communication Line

The following machines can be used to distribute information on a narrowband communication line.

1. Teletypewriter

2. Slow speed data

The machines can be alternately used on a single narrow-band line or each machine can be connected to its own permanent line.

B. Voice Grade Communication Line

The following machines can be utilized with a telephone communication line.

1. Voice grade, Audio (telephone - regular dial or private line)

2. Dataphone (to connect your data equipment into the regular dial telephone system)

3. Computer-assisted instruction (CAI)

4. Facsimile

5. Slow scan television

6. Electronic writer

Most of the above terminal communications hardware alternately can be connected to a telephone line, or one machine can be connected to its own permanent telephone line. If some equipments are needed simultaneously, then they can be connected permanently to many telephone lines. Any one of the terminal hardware in Section A can be utilized with an audio telephone and the proper additional terminal or channelizing equipment. Another combination is that all three machines in Section A can be utilized on one voice grade communication line with proper terminal equipment.

C. <u>Wide-Band Communication Line</u>

Wide-band lines are used for the exchange of video or television information. The following material must utilize the wide-band line.

1. Standard television programs (video and audio)

2. High resolution video, closed circuit type

3. Videofile

Each system used will need a wide-band communication line. Each can, alternately use at different times one wide-band communication line, or if several are needed simultaneously, then each will need one permanently connected wide-band line. Also, alternate use of several machines from Sections A and B can be utilized and connected to a wide-band line with proper terminal or channelizing equipment. Another combination is that all the machines in Sections A and B can be utilized on one wide-band communication line with proper terminal equipment.

COMMUNICATIONS HARDWARE

Teletypewriter - Permanent record, 2-way quick feedback, Ind. console cost under $1,000

For Instruction:

1. Group Project
2. Individual Project
3. Simulation
4. Game
5. Lab
6. Library Resource

For Administration:

1. Curriculum Planning
2. Scheduling
3. Grading
4 Record
5. Evaluation
6. Costing
7. Accounting

Combination Use, Utilizing Narrow-Band Communication Lines:

1. Teletypewriter + Slow Speed Data

   a. Group project, individual project, simulation, game, lab, library resource.

   b. Curriculum planning, scheduling, grading, record, evaluation, costing, and accounting.

Alternate Use; Utilizing Narrow-Band Communication Lines:

The teletypewriter and Slow Speed Data can be utilized alternately on a narrow-band communication line or each machine can be connected directly to its permanent line.

COMMUNICATIONS HARDWARE

Slow Speed Data - Permanent Record, 2-way quick feedback, Ind. console cost under $1,000.

For Instruction:

1. Group Project
2. Individual Project
3. Simulation
4. Game
5. Lab
6. Library Resource

For Administration:

1. Curriculum Planning
2. Scheduling
3. Grading
4. Record
5. Evaluation
6. Costing
7. Accounting

Combination Use; Utilizing Narrow-Band Communication Lines.

1. Slow Speed Data + Teletypewriter

   a. Group project, individual project, simulation, game, lab, library resource.

   b. Curriculum planning, scheduling, grading, record, evaluation, costing and accounting.

Alternate Use; Utilizing Narrow-Band Communication Line.

The Slow Speed Data and Teletypewriter can be utilized alternately on a narrow-band communication line or each machine can be connected directly to its permanent line.

COMMUNICATIONS HARDWARE

Voice Grade, Audio - Audio, 2-way quick feedback, regular telephone system.

For Instruction:
1. Lecture
2. Group Project
3. Individual Project
4. Simulation
5. Game
6. Home Project

For Administration
1. Curriculum Planning
2. Scheduling

Combination Use; Utilizing Telephone Communications:
1. Audio + Dataphone
    a. Lecture, discussion, group project, individual project, simulation, game, lab.
    b. Curriculum planning, scheduling, record, evaluation, accounting.
2. Audio + Slow Scan TV
    a. Lecture, group project, individual project, simulation, game, home project
    b. Curriculum planning, scheduling, evaluation.
3. Audio + Facsimile
    a. Lecture, group project, individual project, simulation, game, home project.
    b. Curriculum planning, scheduling, evaluation.
4. Audio + CAI
    a. Lecture, group project, individual project, simulation, game, home project.
    b. Curriculum planning, scheduling, evaluation.
5. Audio + Electronic writer, both can be utilized together on the same telephone line with proper terminal or channelizing equipment, similar to Sylvania Blackboard by wire system or Victor Electrowriter system.

Alternate Use; Utilizing Telephone Communication Lines:

A voice grade audio system can be used on a telephone line with an Electronic writer, Teletypewriter or slow speed data machines with the proper terminal equipment.

All of the above machines in the combination use can be used individually on separate telephone lines, simultaneously, when additional exchange of information is required.

COMMUNICATIONS HARDWARE

Dataphone - Permanent record, Static Picture, 2-way quick feedback, Ind. console cost under $500.

For Instruction:
1. Discussion
2. Group Project
3. Individual Project
4. Game
5. Library Resource
6. Home Project

For Administration:
1. Curriculum Planning
2. Scheduling
3. Evaluation
4. Costing
5. Accounting

Combination Use; Utilizing Telephone Communication Lines:

1. Dataphone + Slow Scan Television
   a. Lecture, discussion, group project, individual project, game, library resources, home project.
   b. Curriculum planning, scheduling, evaluation.

2. Dataphone + CAI
   a. Lecture, discussion, group project, individual project, game, library resource, home project.
   b. Curriculum planning, scheduling, evaluation.

3. Dataphone + Facsimile
   a. Lecture, discussion, group project, individual project, game, library resource, home project.
   b. Curriculum planning, scheduling, evaluation.

4. Dataphone + Audio
   a. Lecture, discussion, group project, individual project, game, library resource, home project.
   b. Curriculum planning, scheduling, evaluation.

Alternate Use; Utilizing Telephone Communication:

The above machines can be used individually on separate telephone lines, simultaneously, when additional exchange of information is required.

COMMUNICATIONS HARDWARE

Computer Assisted Instruction (CAI) - Static Picture, Audio, 2-way quick feedback

For Instruction:

1. Individual Project
2. Simulation
3. Game

For Administration:

1. Curriculum Planning
2. Scheduling

Combination Use; Utilizing Telephone Communication Line:

1. CAI + Slow Scan TV
   a. Individual project, simulation, game
   b. Curriculum planning, scheduling.

2. CAI + Facsimile
   a. Lecture, discussion, group project, individual project, simulation, game, home project.
   b. Curriculum planning, scheduling, evaluation.

3. CAI + Dataphone
   a. Group project, individual project, simulation, game, lab, library resource.
   b. Curriculum planning, scheduling, grading, record, evaluation, costing, accounting.

4. CAI + Audio
   a. Group project, individual project, simulation, game, lab, library resource.
   b. Curriculum planning, scheduling.

Alternate Use; Utilizing Telephone Communication Lines:

The above machines can be used individually on separate telephone lines, simultaneously, when additional exchange of information is required.

COMMUNICATIONS HARDWARE

Facsimile - Permanent record, Static picture.

For Instruction:

1. Group Project
2. Library Resource

For Administration:

1. Curriculum Planning
2. Scheduling
3. Costing

Combination Use; Utilizing Telephone Communication Lines:

1. Facsimile + Dataphone
   a. Discussion, group project, game, library resource, home project.
   b. Curriculum planning, scheduling, evaluation, costing, accounting.

2. Facsimile + Audio
   a. Discussion, group project, game, library resource, home project.
   b. Curriculum planning, scheduling, evaluation, costing, accounting.

3. Facsimile + CAI
   a. Discussion, group project, game, library resource, home project.
   b. Curriculum planning, scheduling, evaluation, costing, accounting.

4. Facsimile + Slow Scan TV
   a. Discussion, group project, game, library resource, home project.
   b. Curriculum planning, scheduling, evaluation, costing, accounting.

Alternate Use; Utilizing Telephone Communication Lines:

The above machines can be used individually on separate telephone lines, simultaneously, when additional exchange of information is required.

COMMUNICATIONS HARDWARE

Slow Scan TV - Moving Display (partial), Static Picture.

For Instruction:

1. Lectures
2. Discussion
3. Group Project
4. Simulation
5. Game
6. Lab

For Administration

1. Scheduling
2. Records

Combination Use; Utilizing Telephone Communication Line:

1. Slow Scan TV + Audio
   a. Lecture, discussion, group project, simulation, home project.
   b. Curriculum planning, and evaluation.

2. Slow Scan TV + Dataphone
   a. Group Project, individual project, simulation, game, lab, library resource.
   b. Curriculum planning, scheduling, grading, record, evaluation, costing, accounting.

3. Slow Scan TV + Facsimile
   a. Lecture, group project, individual project, simulation, game, and home project.
   b. Curriculum planning, scheduling, evaluation.

4. Slow Scan TV + CAI
   a. Individual project, simulation, game.
   b. Curriculum planning, scheduling.

Alternate Use; Utilizing Telephone Communication Line:

The above machines can be used individually on separate telephone lines, simultaneously, when additional exchange of information is required.

COMMUNICATIONS HARDWARE

Electronic Writer - Permanent record, moving display (partial), Ind. console cost under $1,000; similar to Victor Electrowriter and Concord Interwriter Machines.

For Instruction:

1. Lecture
2. Discussion
3. Group Project
4. Game
5. Home Project

For Administration:

1. Curriculum Planning
2. Scheduling
3. Evaluation

Combination Use; Utilizing Narrow-Band Communication Lines:

1. Electronic writer + Slow Speed Data

   a. Lecture, discussion, group project, individual project, game library resource, and home project.

   b. Curriculum planning, scheduling, and evaluation.

2. Electronic writer + Teletypewriter

   a. Discussion, group project, game, library resource, and home project.

   b. Curriculum planning, scheduling, evaluation, costing, accounting.

Alternate Use; Utilizing Narrow-Band Communications Lines:

The Electronic writer, Slow Speed Data and Teletypewriter can be utilized alternately on a narrow-band communication line or each machine can be connected directly to its permanent line.

COMMUNICATIONS HARDWARE

Standard Television - permanent record, moving picture

For Instruction :

1. Group Project
2. Individual Project
3. Simulation
4. Lecture
5. Lab
6. Library Resources

For Administration:

1. Curriculum Planning
2. Scheduling
3. Grading
4. Record

Combination Use; Utilizing Wide-Band Communication Lines:

1. Standard Television + High resolution video (CCTV)

   a. Group project, individual project, simulation, lecture, lab, library resource.

   b. Curriculum planning, scheduling, grading, record, evaluation, costing, and accounting.

2. Standard Television + Videofile

   a. Lecture, discussion, group project, individual project, simulation, game, lab, library resource.

   b. Curriculum planning, scheduling, grading, record, evaluation, costing, accounting.

Alternate Use; Utilizing Divide Band Communication Lines:

The above systems can be used individually on separate wide-band lines, simultaneously, when additional exchange of information is required. All of the machines in the narrow-band and telephone line categories can be utilized together on one wide-band communication line.

COMMUNICATIONS HARDWARE

High Resolution Video - Permanent record, moving display

For Instruction:

1. Lecture
2. Discussion
3. Group Project
4. Game
5. Home Project
6. Lab
7. Library Resource

For Administration:

1. Curriculum Planning
2. Scheduling
3. Evaluation
4. Record
5. Costing
6. Accounting

Alternate Use; Utilizing Wide-Band Communication Lines.

The above systems can be used individually on separate wide-band line, simultaneously, when additional exchange of information is required. All of the machines in the narrow-band and telephone line categories can be utilized together on one wide-band communication line.

COMMUNICATIONS HARDWARE

VIDEOFILE - Permanent record, Static Picture

For Instruction:

1. Lecture
2. Discussion
3. Group Project
4. Individual Project
5. Lab
6. Library Resource

For Administration:

1. Curriculum Planning
2. Scheduling
3. Record
4. Evaluation
5. Accounting

Combination Use; Utilizing Wide-Band Communication Lines:

1. Videofile + Television

   a. Lecture,discussion, group project, individual project, simulation, game, lab, library resource

   b. Curriculum planning, scheduling, record, evaluation, accounting.

2. Videofile + High resolution video

   a. Lecture, discussion, group project, individual project, game, lab, library, resource, home project.

   b. Curriculum planning, scheduling, record, evaluation, accounting.

Alternate Use; Utilizing Wide-Band Communication Lines:

The above systems can be used individually on separate wide-band line, simultaneously, when additional exchange of information is required. All of the machines in the narrow-band and telephone line categories can be utilized together on one wide-band communication line.

APPENDIX F

OPEN-CIRCUIT BROADCAST TELEVISION SERVICE

APPENDIX F
OPEN-CIRCUIT BROADCAST TELEVISION SERVICE

Introduction

This section is concerned with the development of a regional educational television system for the Central Michigan Educational Resources Council. The primary goal is the establishment of a network of broadcast television stations which will provide at least one ETV service throughout the region.

Numerous discussions were held with representatives of the Council for the purpose of obtaining information regarding current and future needs of the educational television system. Several visits were for the purpose of evaluating the performance in terms of coverage area of existing VHF and UHF television stations and to specific selection of proposed transmitter sites.

The engineering studies encompassed the technical design and operation for the educational television network. Included in other sections of this report are considerations of the Federal Communications Commission and technical standards for the proposed system. Recommended transmitter locations, proposed coverage areas, population served, existing and proposed studio locations, and transmitter operating parameters are specified in this appendix, including typical equipment requirements and estimated costs. Special area situations are discussed, and a logical construction program outline endeavoring to comprehend future requirements is developed. Ultimate activation of the total plan or any portion will depend upon securing the approval of the Federal Communications Commission (FCC) for the proposed radiating facilities. The additional channel needed at Traverse City must be requested via rulemaking with the FCC, and the approval of the Federal Aviation Administration must be obtained for all required tower structures.

FCC Table of ETV Assignments in the Center Peninsula Region

The opportunity to establish a state-wide educational television system has been provided by the Federal Communications Commission. There are a total of 957 authorized television stations in the United States, of which 595 utilize the VHF channels and 362 occupy the UHF channels. This number includes 179 non-commercial educational stations of which 76 operate in VHF range and 103 in the UHF range. Availability of channels is determined by a Table of Assignments contained in the Rules of the Federal Communications Commission which lists the various cities and towns in the nation. The present Table list 1,756 VHF and UHF assignments to 792 cities in the contiguous 48 states. Of this total 615 channels are reserved for non-commercial television (ETV) use (107 VHF and 508 UHF).

The television channels presently reserved by the FCC for non-commercial use in the Michigan Central Peninsula are as follows:

Table I

City of Assignment	Reserved Channel No.
1) Alpena	6
2) Bad Axe	15
3) Bay City	19 (On air)
4) Cadillac	27
5) Manistee	21
6) Mount Pleasant	14 (On air)
7) Petoskey	23
8) West Branch	24

With these eight ETV reserved assignments it is possible to cover almost all of the region. To obtain complete coverage for the region one additional channel may be needed at or near Traverse City.

Availability of Additional Assignments

Additional channel assignments may be added to the FCC Table of Assignments in accordance with prescribed rulemaking procedures. A computer study was made to find an additional assignment within the scope of the Commission's Rules. Channel 18 was found by the computer to be suitable for use in or near Traverse City.

Rulemaking proceedings will have to be instituted with the FCC for the additional channel assignment.

Existing Educational Television Stations in the Lower Peninsula

Educational television in the central peninsula is now represented by the following two full-time stations:

Station WCMU-TV is operating in Mount Pleasant by Central Michigan University on Channel 14 with an effective radiated power of 39.8 kilowatts and an effective antenna height of 520 feet. The low power and relatively low tower severely restrict the station coverage to less than 20 miles.

Station WUCM-TV is operated near Bay City by Delta College on Channel 19 with an effective radiated power of 234 kilowatts and an effective antenna height of 470 feet.

Proposed Educational Television System

General

In order to provide a regional, open-circuit educational broadcast television service up to 9 stations may be required. These stations, including the authorized stations, will provide at least one broadcast educational television service to the entire region. Of the total of nine stations, four are secondary in nature and may not actually be needed with advancing receiver technology. Five stations, including the existing stations when modified to full height and power, will provide primary coverage.

The transmitting facilities have been located in proximity to the population centers so that the television signal will be most intense in built-up areas to provide satisfactory coverage where large buildings and trees tend to obstruct the UHF television signals. Signal propagation is much more favorable in suburban and rural areas so that in general, these localities can secure comparable service in the presence of lower values of signal strength.

Supplemental broadcast services such as translators and community antennas can provide reception in some of the areas in the central peninsula of Michigan. Cable systems are providing some television service in Petoskey, Traverse City, Alpena and Oscoda and must carry educational television programming when it is broadcast locally. Translator service can provide local "fill-in" service where regular broadcast reception or cable system service is inadequate.

Transmitter Site Selection Considerations

The location of television transmitting plants is subject to the numerous provisions of the Rules of the FCC as well as those of the Federal Aviation Administration. In addition, there may be local ordinances and building codes which must be complied with or special exceptions to be negotiated. Specifically, the Federal Communications Commission requires that the proposed location, taking into account the effective radiated power and antenna height, provide at least a specified level of signal over the entire principal city to be observed. In addition, the selected location must satisfy certain mileage requirements with respect to the distance from other stations or assignments on the same or adjacent channels. These distances are required to prevent interference between the stations.

The Federal Aviation Administration (FAA) is responsible for safe practices in the aeronautical service and, therefore, must maintain adequate clearance between specified minimum flight altitudes and obstructions in regularly used airlanes and near airports. This means that the Federal Aviation Administration routinely reviews all proposed structures having a height greater than 200 feet above ground which could interfere with flight patterns as they have been established and the flight altitudes as they are currently used. No attempt has been made in the study to secure FAA approval of any of the sites indicated. Such matters are beyond the scope of this particular study. However, an effort has been made to specify sites in proximity to other existing towers or in areas where the additional aeronautical hazards of any such new construction appears to be at a minimum.

Proposed Transmitting Facilities and Recommended Locations

The proposed transmitter sites were selected from terrain, service area needs, and station spacing criteria. On-site inspections were made of the sites to determine the land suitability for transmitter buildings, tower locations, road accessibility, AC power availability, and other general site conditions. Several photographs were taken of each selected transmitter location. Using the sites proposed, an effective radiated power of 200 to 500 kilowatts is recommended with an effective antenna height of 500 to 1000 feet for each staion. These parameters give a calculated Grade B contour of approximately 30.5 to 40 miles radius. The proposed VHF Channel 6 television station assigned to Alpena is recommended to have the maximum radiated power of 100 kilowatts, with an effective antenna height of 1000 feet.

Plans for implementing the proposed open-circuit educational broadcast television system should be evolved in three stages as follows:

Stage I	Alpena, Channel 6
	Cadillac, Channel 27

Stage II	Mt. Pleasant, Channel 14 (relocation)
	Bay City, Channel 19 (relocation)
Stage III	Manistee, Channel 21
	Bad Axe, Channel 15
	Petoskey, Channel 23
	West Branch, Channel 24

Figure 3 shows the sequence of the stages (I to III) recommended for the construction and operation of the proposed broadcast television stations.

A summary of the capital cost, operating cost and phase of each proposed educational broadcast television station is given in Table II page F-13. Tables III to VIII list capital costs of the transmitting stations. Table IX lists the annual operating costs of a typical 25 kw, VHF, transmitting plant, 10 kw, UHF, transmitting plant and 30 kw, UHF, transmitting plant.

Stage I

1. Alpena

The ETV state-wide plan proposes to utilize Channel 6 which is assigned to Alpena. The proposed transmitter site should be located west of Alpena for maximum coverage of the land area. The recommended site is ten miles west of Long Rapids, 15 miles west of Alpena, and must maintain at least 170 miles co-channel separation from Channel 6 to Lansing. The ground elevation is 800 to 850 feet AMSL. The general area was inspected and was found to have generally flat terrain, good roads, houses and AC power. Ample farmland is available for a proposed television tower and transmitting building.

It is recommended that the station be operated with an effective radiating power of 100 kilowatts and an effective antenna height of 1000 feet above average terrain. The location of the transmitting antenna provides good line-of-sight to the assigned city of Alpena and provides maximum coverage to its surrounding areas. The proposed site is located about 5 miles from an airlane. See Table VII for capital cost of transmitting station.

2. Cadillac

The second station to be activated should be reserved Channel 27 at Cadillac. Construction should be concurrent with the Alpena Channel 6 so that together, these two stations can offset most of the service expected to be lost by the withdrawal of time by the commercial stations in the area. Channel 27 should be constructed at the fire tower on Briar Hill, approximately 15 miles northwest of Cadillac. Ground elevation is 1700 feet above sea level with access and AC power believed to be reasonable. A second choice of site would be either at the transmitting site of Channel 7 (WPBN-TV) seven miles to the south, or at Fife Lake State Forest, eight miles to the east.

It is proposed that the staion be operated with an effective radiated power of 500 kilowatts and an effective height of at least 1000 feet above average terrain. The location of the transmitting antenna provides good propagation into the assigned city of Cadillac and generally into Traverse City. The site should encounter no aeronautical problems. See Table IV for capital cost of transmitting station.

Stage II

3. Mount Pleasant

Central Michigan University operates WCMU-TV Channel 14 with an effective radiated power of 39.8 kilowatts and an effective antenna height of 520 feet. It is recommended that the transmitter be moved to higher ground elevation approximately 10 miles west of Mount Pleasant, off highway 20. This location is developed and readily accessible with ample land available for tower and building construction. The facilities should be increased to an effective radiated power of at least 500 kilowatts with an effective antenna height of 1000 feet. Approximately 750 feet of tower will be required at this site. With the new location and facilities, station WCMU-TV can obtain a sizeable coverage compatible with other region stations. See Table III for cost details.

4. Bay City (University Center)

Station WUCM-TV, channel 19 is licensed to Delta College and operates with an effective radiated power of 234 kilowatts and an effective antenna height of 470 feet. These parameters are adequate for the present but should be increased to an effective antenna height of 1,000 feet in Stage II. Aeronautical limitations appear to restrict the tower height at its present site. Therefore, a move to the east or southeast would be needed for a higher tower, unless approach procedures to Midland airport were changed to permit the 1000 foot tower at its present site. With these new facilities, station WUCM-TV can obtain adequate coverage. See Table II for cost details.

Stage III

5. Manistee

A later part of the broadcast plan would utilize Channel 21 which is assigned to Manistee. The proposed transmitter station should be located about 12 miles east of Manistee off highway 55 on Udell Mountain near the fire lookout tower. The general area was inspected and found suitable. A dirt road leads to the fire tower and there is ample land for tower and transmitting building. AC power and road improvements will be needed at the site. It is proposed that the station be operated with an effective radiated power of at least 200 kilowatts and an effective antenna height of at least 500 feet above average terrain. The location of the transmitting antenna provides good coverage to the city of Manistee and maximum coverage to its surrounding area. The proposed transmitting site is about 6 miles east of any airlane. See Table V for capital cost of transmitting station.

6. Bad Axe

The proposed Channel 15 at Bad Axe should be located about 9 miles south of Bad Axe, ground elevation of 850 feet, AMSL. The area is non-critical having developed roads, ample land for a tower, AC power, and easy access to the area. The station should be operated with an effective radiated power of 200 kilowatts and an effective antenna height of 500 feet above average terrain. The location provides clear line-of-sight to Bad Axe and is not near any airlanes or airports. See Table V for capital cost of transmitting station.

7. Petoskey

In the ETV plan, Channel 23 assigned to Petoskey may be utilized. The transmitter site should be located about 7 miles southeast of Petoskey, on Bear Creek Lookout Tower Hill with a ground elevation of 1295 feet AMSL. The general area was inspected, an adequate road leads to the fire tower, FAA radio beacon towers, two-way communication tower and high voltage AC lines nearby. Ample land is available for proposed television tower and building. It is proposed that the station be operated with an effective radiated power of 200 kilowatts and an effective antenna height of 500 feet above average terrain. The antenna location can provide good coverage to the city of Petoskey and surrounding area. The site is about 5 miles east of an airlane. See Table VI for capital cost of transmitting station.

8. Traverse City

At present, Traverse City has no ETV reservation assigned to it. A computer study for a UHF television channel was made in the Traverse

City area and Channel 18 was found available for Traverse City. The transmitter station should be located about 3 miles northwest of the city near the WPBN-TV Channel 7 studio and auxiliary tower, 1546 AMSL, 1130 feet ground elevation. The site is developed with available AC power and has a good road. The general area was inspected and was found to have ample land for the tower and transmitting building. It is proposed that the station be operated with an effective radiated power of at least 500 feet above average terrain. The antenna location provides good line-of-sight into Traverse City. Because of its proximity to Channel 7, no aeronautical problem is anticipated. See Table V for capital cost of transmitting station.

9. West Branch

Channel 24, assigned to West Branch, could be utilized in the overall ETV plan. The transmitter site should be located about 5 miles north of West Branch with a ground elevation of 1350 feet AMSL. The general area was inspected and was found to have dirt roads, houses, and AC power. There is ample farmland for proposed television tower and transmitting building. AC power and road to the site may be needed. It is proposed that the station be operated with an effective radiated power of 200 kilowatts and an effective antenna height of 500 feet above average terrain. The location provides clear line-of-sight to the area. The proposed location is more than 5 miles away from any airlanes. For capital cost of transmitting station, see Table V.

Estimated Schedule for Technical Construction

There are four time-consuming processes in construction of a television station and its interconnecting microwave link. Using a general plan such as presented in this report, detailed engineering and administrative planning can consume six to twelve months. The preparation of each application for construction permit to the FCC could require three to five months additional time. If matching federal funds were planned to be used, appropriate applications for such funds must be made simultaneously with the FCC application. After the application has been filed with the Commission, a construction permit may be granted in approximately three months provided no unusual procedures arise or protests are filed against making such a grant. If protests are received from the Federal Aviation Agency or from other parties which have television interests in the area which they feel may be jeopardized by the construction of a new television station, they will be given an opportunity by the Commission to file their comments and objections. If these objections are felt to be substantial the Commission may designate the application for hearing. If the application requests exceptions or changes in the FCC rules of such a nature that other parties may be aggrieved or have an interest in them, the Commission also may designate the matter for hearing. An FCC hearing almost always involves at least one year and in some cases involves as many as two to five years litigation. As a consequence, it is desirable to stay within prescribed limits of the Commission's rules whenever possible. Some of the time periods outlined above could run concurrently so that the over-all elapsed time would possibly be shorter than a simple summation of time would indicate.

Once the application for construction has been granted, final equipment orders may be placed with equipment manufacturers and construction started on the transmitter building and the foundation for the tower. It must be emphasized that under no circumstances can any construction be started on the transmitter, its building, or the tower foundations prior to the time that a construction permit has been granted by the Federal Communications Commission. Failure to observe this caution can result in forced abandonment of all construction prior to the data of the construction permit.

Since the tower foundations and the building must wait for warm weather to permit pouring of concrete, it is advantageous to have the preliminary plans and contracts arranged during cold weather so that construction may start immediately in the spring. Television equipment, towers, and transmitting antennas are in good supply and in most cases can be provided on a three-to-six month basis.

Although land options should be obtained prior to the filing of an application for construction, the actual purchase or leasing of the land can be deferred until a construction permit is granted. Site testing and soil boring also can be taken care of prior to the filing of an application to permit verification of the suitability of the proposed site. Any permanent site improvement such as extensive clearing of the land, construction of a permanent access road, water. and power installation should not be done until after the construction permit has been granted. A great deal of detailed planning is necessary before any station can go on the air. Unnecessary and expensive delays can result if all the activities are not coordinated carefully. Of course, several activities may be undertaken at the same time or in sequence depending on work priorities and schedules.

Typical time estimates of various categories are as follows:

1.	A nonreserved channel assignment to air time (requires rulemaking)	2 years
2.	A reserved channel to air-time	1-1/2 years
3.	An existing reserved channel with construction permit (assuming some modification of CP would be necessary) to air-time	1 year
4.	Studio production center	
	a. Modernization of existing facility	1 year
	b. Construction and activation of major production complex	2 years

It is also important to emphasize that the cost estimates in this report are for budgetary purposes only. These costs can vary somewhat because of specific modifications during implementation and price changes with time for the equipment and services required.

TABLE II

SUMMARY OF CAPITAL COST & ANNUAL TRANSMITTING OPERATIONAL COSTS OF PROPOSED ETV BROADCASTING STATIONS

Stages	Description	Capital Cost	Annual Transmitting Operational Cost*
I	Channel 6, Alpena (100 kw ERP at 1000 ft AAT)	$ 542,500	$ 35,560
	Channel 27, Cadillac (500 kw ERP at 1000 ft AAT)	492,500	49,600
II	Channel 14, Mt. Pleasant (500 kw ERP at 1000 ft AAT)	610,200	49,600
	Channel 19, Bay City (500 kw ERP at 1000 ft AAT)	612,500	49,600
III	Channel 21, Manistee (200 kw ERP at 500 ft AAT)	424,900	37,120
	Channel 15, Bad Axe (200 kw ERP at 500 ft AAT)	424,900	37,120
	Channel 23, Petoskey (200 kw ERP at 500 ft AAT)	374,900	37,120
	Channel 18, Traverse City (200 kw ERP at 500 ft AAT)	424,900	37,120
	Channel 24, West Branch (200 kw ERP at 500 ft AAT)	424,900	37,120
	Grand Total	$ 4,332,200	$ 369,960

* 60 hours per week operation

TABLE III

ESTIMATED CAPITAL COSTS FOR UHF STATION
500,000 WATTS ERP, 1000 FT. TOWER

Quantity	Equipment	Cost
1	30-kilowatt transmitter, including sideband filter, diplexer and harmonic filters	$ 210,000
1	Spare Tubes	15,000
1	Transmitter Control Console, including picture and waveform monitors and local slide equipment	13,000
1 set	Transmitter input and monitoring equipment	18,500
1	Guyed, 1,000-foot antenna supporting tower	150,000
1	Antenna, 30-gain with lighting protector	35,000
1	RF load and wattmeter	3,700
1,100 ft	6-1/8 inch transmission line (including hangers, elbows, etc.)	34,000
1	Line pressurizing equipment	1,500
Misc.	Fixed hangers, adaptors, inside fittings, hardware kits, clamps, connectors, valves and gassing accessories	2,500
1 set	Test equipment	7,800
	Land (40 acres)	40,000
	Building, site improvement and roadway	40,000
	Furniture and fixtures	2,500
	Installation, legal and engineering, freight	19,000
	Contingencies	20,000
	Total	$ 612,500

TABLE IV

ESTIMATED CAPITAL COSTS FOR UHF STATION
500,000 WATTS, ERP 750 FT. TOWER

Quantity	Equipment	Cost
1	30-kilowatt transmitter, including sideband filter, diplexer and harmonic filter	$ 210,000
1 set	Spare tubes	15,000
1	Transmitter Control Console, including picture and waveform monitors and local slide equipment	13,000
1 set	Transmitter input and monitoring equipment	18,500
1	Guyed, 750-foot antenna supporting tower	100,000
1	Antenna, 30-gain with lightning protector	35,000
1	RF load and wattmeter	3,700
850 ft.	6-1/8 inch transmission line (including hangers, elbows, etc.	27,000
1	Line pressurizing equipment	1,500
Misc.	Fixed hangers, adaptors, inside fittings, hardware kits, clamps, connectors, valves and gassing accessories	2,000
1 set	Test equipment	7,800
	Land (25 acres)	25,000
	Building, site improvement and roadway	40,000
	Furniture and fixtures	2,500
	Installation, legal and engineering, freight	19,000
	Contingencies	20,000
	Total	$ ~~610,200~~ 540,000

TABLE V

ESTIMATED CAPITAL COSTS FOR UHF STATION
500,000 WATTS ERP, 500 FT. TOWER

Quantity	Equipment	Cost
1	30-kilowatt transmitter, including sideband filter, diplexer and harmonic filters	$ 210,000
1 set	Spare Tubes	15,000
1	Transmitter control console, including picture and waveform monitors and local slide equipment	13,000
1 set	Transmitter input and monitoring equipment	18,500
1	Guyed, 500-foot antenna supporting tower	75,000
1	Antenna, 30-gain with lightning protector	35,000
1	RF load and wattmeter	3,700
600 ft.	6-1/8 inch transmission line (including hangers, elbows, etc.)	20,000
1	Line pressurizing equipment	1,500
Misc.	Fixed hangers, adaptors, inside fittings, hardware kits, clamps, connectors, valves and gassing accessories	1,500
1 set	Test equipment	7,800
	Land (10 acres)	10,000
	Building, site improvement and roadway	40,000
	Furniture and fixtures	2,500
	Installation, legal and engineering, freight	19,000
	Contingencies	20,000
	Total	$ 492,500

TABLE VI

ESTIMATED CAPITAL COSTS FOR UHF STATION
200,000 WATTS ERP, 500 FT. TOWER

Quantity	Equipment	Cost
1	10-kilowatt transmitter, including sideband filter, diplexer and harmonic filters	$ 150,000
1 set	Spare tubes	8,300
1	Transmitter control console, including picture and waveform monitors and local slide equipment	13,000
1 set	Transmitter input and monitoring equipment	18,500
1	Guyed, 500-foot antenna supporting tower	75,000
1	Antenna, 30-gain with lightning protector	35,000
1	RF load and wattmeter	2,800
600 ft.	6-1/8 inch transmission line (including hangers, elbows, etc.)	20,000
1	Line pressurizing equipment	1,500
Misc.	Fixed hangers, adaptors, inside fittings, hardware kits, clamps, connectors, valves and gassing accessories	1,500
1 set	Test equipment	7,800
	Land (10 acres)	10,000
	Building, site improvement and roadway	40,000
	Furniture and fixtures	2,500
	Installation, legal and engineering, freight	19,000
	Contingencies	20,000
	Total	$ 424,900

TABLE VII

ESTIMATED CAPITAL COSTS FOR UHF STATION
200,000 WATTS ERP, 250 FT. TOWER

Quantity	Equipment	Cost
1	10-kilowatt transmitter, including sideband filter, diplexer and harmonic filters	$ 150,000
1 set	Spare Tubes	8,300
1	Transmitter control console, including picture and waveform monitors and local slide equipment	13,000
1 set	Transmitter input and monitoring equipment	18,500
1	Guyed, 250-foot antenna supporting tower	40,000
1	Antenna, 30-gain with lightning protector	35,000
1	RF load and wattmeter	2,800
350 ft.	6-1/8 inch transmission line (including hangers, elbows, etc.	12,000
1	Line pressurizing equipment	1,500
Misc.	Fixed hangers, adaptors, inside fittings, hardware kits, clamps, connectors, valves and gassing accessories	1,500
1 set	Test equipment	7,800
	Land (3 acres)	3,000
	Building, site improvement and roadway	40,000
	Furniture and fixtures	2,500
	Installation, legal and engineering, freight	19,000
	Contingencies	20,000
	Total	$ 374,900

TABLE VIII

ESTIMATED CAPITAL COSTS FOR VHF STATION AT ALPENA
CHANNEL 6, 100,000 WATTS ERP, 1000 FT. TOWER

Quantity	Equipment	Cost
1	25-kilowatt transmitter, including sideband filter, diplexer and harmonic filters	$ 160,000
1 set	Spare tubes	5,000
1	Transmitter control console, including picture and waveform monitors and local slide equipment	13,000
1 set	Transmitter input and monitoring equipment	18,500
1	Guyed, 1000-foot antenna supporting tower	150,000
1	Antenna, 16-gain, with lightning protector	37,500
1	RF load and wattmeter	2,500
2200 ft.	3-1/8 inch transmittion line (including hangers, elbows, etc.)	23,000
1	Line pressurizing equipment	1,500
Misc.	Fixed hangers, adaptors, inside fittings, hardware kits, clamps, connectors, valves and gassing accessories	2,000
1 set	Test equipment	8,000
	Land (40 acres)	40,000
	Building, site improvement and roadway	40,000
	Furniture and fixtures	2,500
	Installation, legal and engineering, freight	19,000
	Contingencies	20,000
	Total	$ 542,500

TABLE IX

TRANSMITTER OPERATING COST

1. (Typical 25 KW VHF)

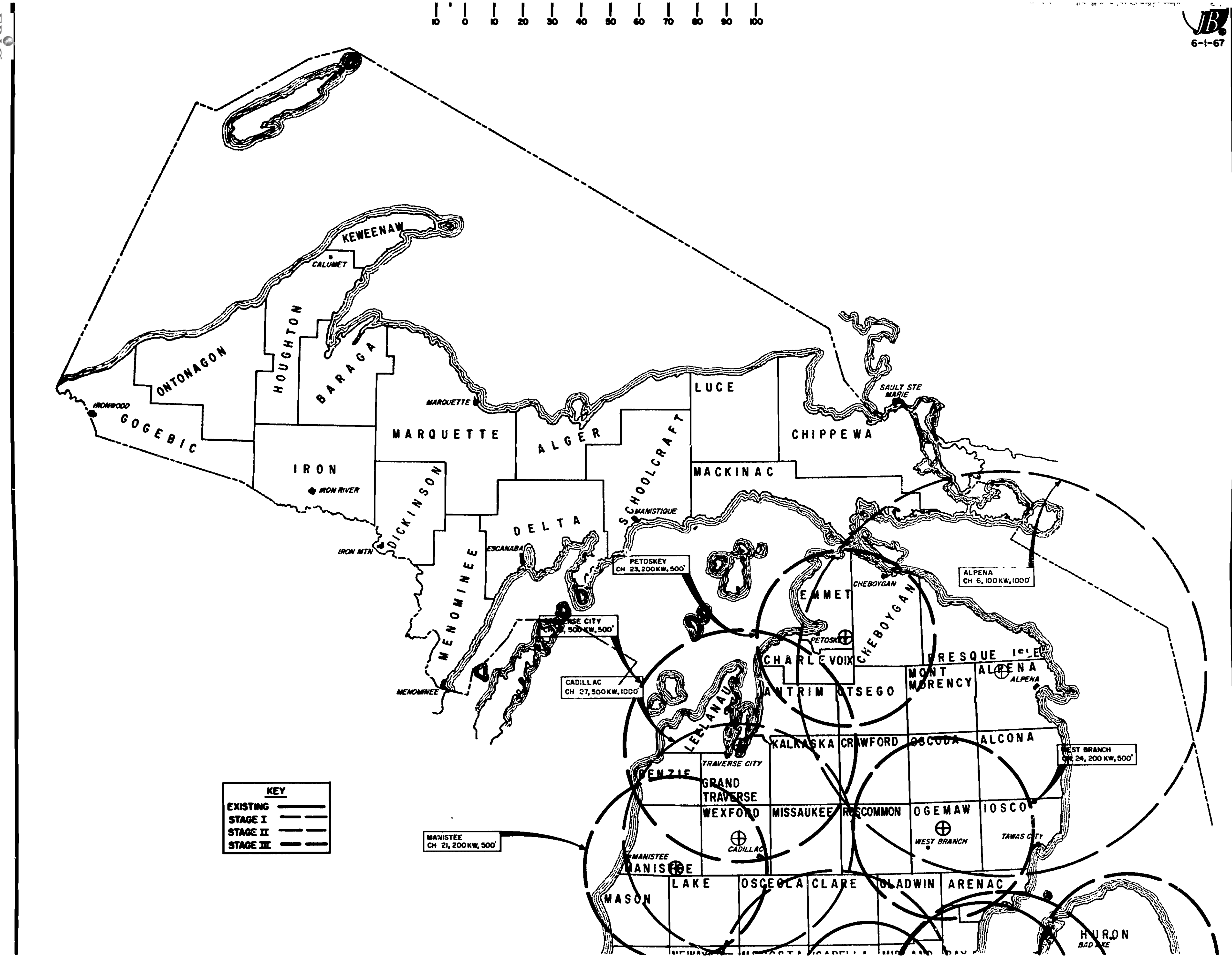
	Annual Cost	
	60 hours per week	100 hours per week
AC Power (100 kw/h at .03 kwh)	$ 9,360	$ 15,500
Tubes and parts @ $1.25 per hour	3,900	6,500
Building and property maintenance	2,500	2,500
Tower maintenance and painting	800	800
Technicians	9,000	18,000
Supervision	10,000	10,000
TOTAL	$ 35,560	$ 53,300

2. (Typical 10 KW UHF)

	Annual Cost	
	60 hours per week	100 hours per week
AC Power (100 kw/h at .03 kwh)	$ 9,360	$ 15,500
Tubes and parts @ 1.75 per hour	5,460	9,100
Building and property maintenance	2,500	2,500
Tower maintenance and painting	800	800
Technicians	9,000	18,000
Supervision	10,000	10,000
TOTAL	$ 37,120	$ 55,900

3. (Typical 30 KW UHF)

	Annual Cost	
	60 hours per week	100 hours per week
AC Power (200 kw/h at .03 kwh)	$ 18,700	$ 31,000
Tubes and parts @ $2.75 per hour	8,600	14,300
Building and property maintenance	2,500	2,500
Tower maintenance and painting	800	800
Technicians	9,000	18,000
Supervision	10,000	10,000
TOTAL	$ 49,600	$ 76,600


10 0 10 20 30 40 50 60 70 80 90 100
6-1-67
KEWEENAW
CALUMET
HOUGHTON
ONTONAGON
BARAGA
GOGEBIC
IRONWOOD
IRON
IRON RIVER
MARQUETTE
DICKINSON
IRON MTN
MENOMINEE
DELTA
ESCANABA
ALGER
SCHOOLCRAFT
MANISTIQUE
LUCE
MACKINAC
CHIPPEWA
SAULT STE MARIE
PETOSKEY CH 23,200KW, 500'
ALPENA CH 6, 100KW, 1000'
CADILLAC CH 27,500KW, 1000'
WEST BRANCH CH 24, 200 KW, 500'
MANISTEE CH 21, 200KW, 500'
EMMET
CHEBOYGAN
CHARLEVOIX
PETOSKEY
PRESQUE ISLE
MONT MORENCY
ALPENA
ANTRIM
OTSEGO
LEELANAU
KALKASKA
CRAWFORD
OSCODA
ALCONA
TRAVERSE CITY
GRAND TRAVERSE
WEXFORD
MISSAUKEE
ROSCOMMON
OGEMAW
IOSCO
CADILLAC
WEST BRANCH
TAWAS CITY
MANISTEE
LAKE
OSCEOLA
CLARE
GLADWIN
ARENAC
MASON
HURON
KEY
EXISTING
STAGE I
STAGE II
STAGE III

KEY

- EXISTING
- STAGE I
- STAGE II
- STAGE III

NOTE:
GRADE B CONTOURS WERE CALCULATED FROM THE PROPOSED FCC TELEVISION PROPAGATION CURVES FOR UHF, DOCKET -16004, APRIL 12, 1966 AND FROM RADIATION IN THE MAXIMUM DIRECTION AS PROPOSED IN DOCKET-17253, MARCH 3, 1967.

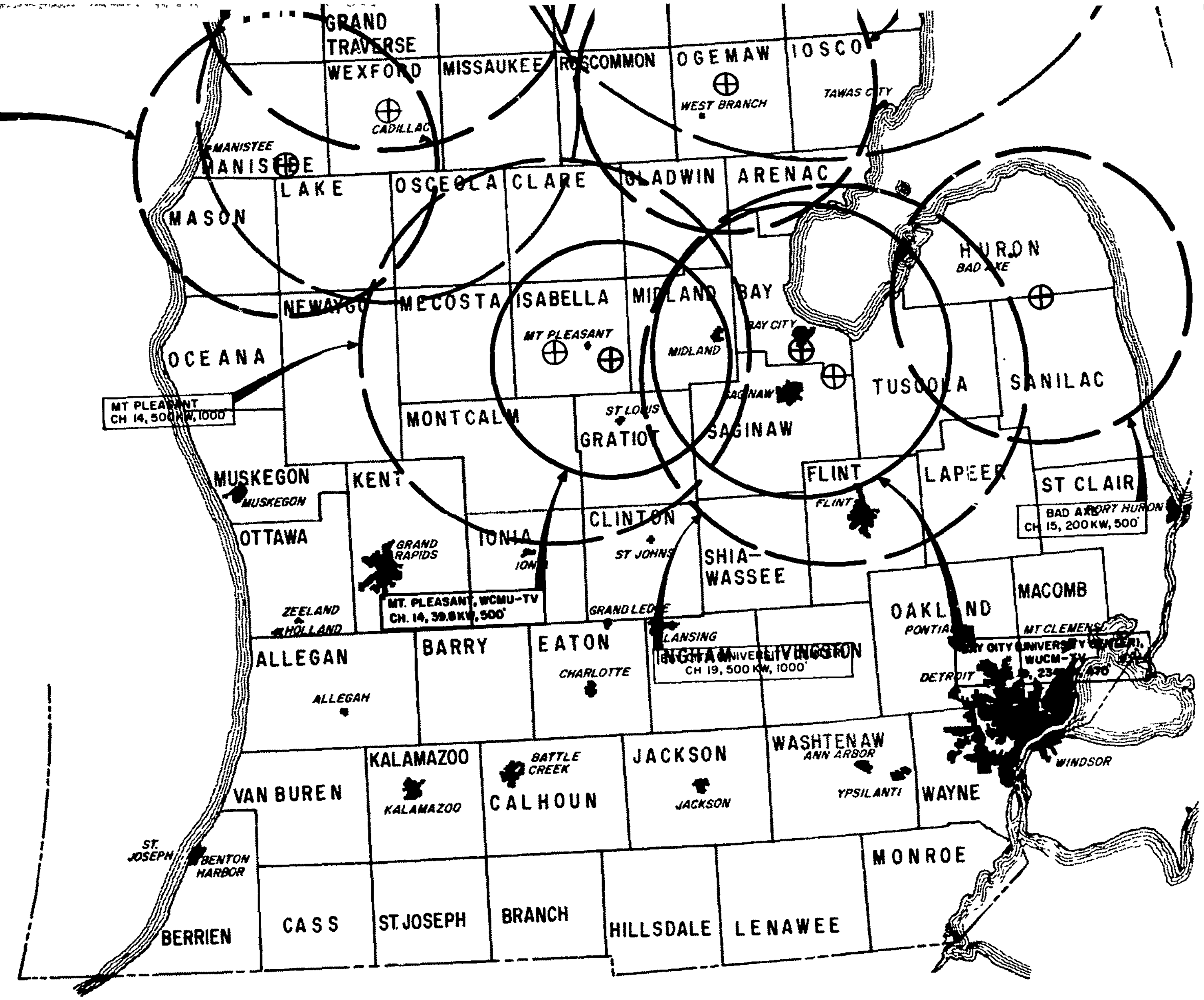


FIG. 3
PROPOSED DEVELOPMENT OF EDUCATIONAL TELEVISION BROADCASTING IN THE LOWER PENINSULA REGION
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APPENDIX G

HISTORY, NATURE, AND SCOPE OF COMMUNITY ANTENNA TELEVISION

APPENDIX G

HISTORY, NATURE AND SCOPE OF COMMUNITY ANTENNA TELEVISION

Community Antenna Television (CATV) is little more than 17 years of age. Its birth and growth were stimulated by the desire of the public in rural and so-called "fringe" television reception areas to enjoy the advantages of this new and dynamic medium of mass communications called television. From a modest beginning, the CATV industry has grown in excess of 1,700 commercial community antenna companies providing television reception and distribution service to approximately 2,100,000 homes, thus making possible either a first, supplementary, or improved television reception service for more than 7,000,000 people. Although the community antenna industry does not constitute a large segment of the television economy, it is well organized and extremely vocal.

A community antenna is, as the term implies, a master television receiving antenna and a distribution system designed and erected to serve a community. It is similar, except for size, to the master antenna systems installed in schools, hotels, and apartment houses to permit service to the rooms by means of a single antenna system.

Until recently, community antennas were found in areas where direct home reception of any television signals by conventional antennas was non-existent, or possible only with the aid of costly, tall roof-top antennas. Usually distance from the TV stations or major terrain obstructions were the reason for unsatisfactory service.

Community antennas are designed to receive the signals of several stations simultaneously. The antennas are oriented to receive the desired signals and to reject, as much as possible, the undesired channels. ITFS and locally originated channels may be included on a calbe system if appropriate.

Community antennas generally do not originate programs except for public service type. They are, therefore, more closely allied with television broadcasting and are a vital adjunct of such service, extending television broadcast reception to many "fringe" reception areas. The **community** antenna has become important for achieving the goals of the Federal Communications Commission of providing a truly nationwide television service.

On March 8, 1966, the FCC issued its Second Report and Order in Dockets 14895, 15233, and 15971 (31 FR 4540) which promulgated general regulation covering all CATV systems. Among other requirements, these regulations make the carriage of all local TV broadcasting stations (including non-commercial channels) mandatory before more distant stations are carried. Further the regulations state that "The signal shall be carried, upon request of the station licensee or permittee, be carried on the system on the channel on which the station is transmitting (where practicable)."

The existence of numerous CATV systems in Michigan provides a practical expedient for obtaining local distribution services in some of the rural communities. While these systems are not bound by a regulated tariff, their equipment should exceed the capability of conventional receivers. Some of the CATV systems provide FM radio and other audio services to their subscribers. Such systems also could provide high fidelity audio programs to educational customers. Many CATV owners have provided a connection service to area schools at no charge as a public service. The internal distribution within the school is frequently done at cost in these instances. The policy of individual CATV systems will vary, however.

The present FCC Rules governing CATV do not permit new cable construction in the major cities of the US without a hearing to determine the wisdom and need for such service. Many large cities have granted franchises for CATV service to cable companies, but whether these systems will ever be constructed is not clear at this time. The FCC is still attempting to clarify its regulation of this industry and a more definitive policy from the U.S. Congress may be required before the regulatory uncertainties are removed.

The growth of CATV has forced an intensive development of high quality equipment and design concepts far superior to those available only a few years ago. In the past, CATV systems were designed around existing hardware and equipment. Now, with greatly increased demand, new hardware, amplifiers, and construction methods have been designed to meet more economic system cost and much higher performance criteria.

Engineering design consideration divides naturally into (a) the antenna site equipment, and (b) the distribution plant. The antenna site equipment includes antennas, preamplifiers, band-pass and rejection filters, automatic and manual gain control, and in some instances demodulators, re-modulators, video correction circuits, and microwave relay terminals. The distribution plant commences at the point where all received channels are mixed into one wide band, frequency division, multiplexed system. It consists of a trunk line which transports the signal to a multitude of distribution points. Several distribution lines branch out from each of these points, and may be tapped for house drops to serve subscribers ordering the service.

The primary objective in the design of a CATV system is to produce a television picture on a TV receiver, either monochrome or color, which the viewer will find acceptable (providing the viewer has an acceptable receiver and a satisfactory signal is received at the input to the transmission facilities.) Generally speaking, this can be accomplished by the selection of suitable components, by the proper locations of these components in the system, and by operating them within specified limits.

The following picture quality rating scale will help orient the viewer with the rating scale developed by TASO during its studies of 1959.

Grade No.	Name	Description
1	Excellent	Picture is of extremely high quality, as as good as you could desire.
2	Fine	Picture is of high quality providing enjoyable viewing. Interference is perceptible.
3	Passable	Picture is of acceptable quality. Interference is not objectionable.
4	Marginal	Picture is poor in quality and you wish you could improve it. Interference is somewhat objectionable.
5	Inferior	Picture is very poor but you could watch it. Definitely objectionable interference is present.

Although entertainment TV will have viewer acceptance at grade 3, it is our judgement that Educational and Instructional TV must have at least a grade 2 picture for at least 95 percent of the time.

The following Quality Grade definitions are related more specifically to CATV or Building Distribution Systems.

<u>Better Quality</u>

95% of observers viewing pictures at all parts of the system would rate the Picture Quality as "Fine" or grade 2. At least 80% of observers viewing pictures at the extremity of the system would also rate the Picture Quality as "Fine". The picture is of high quality providing enjoyable viewing. Interference is perceptible.

<u>Good Quality</u>

90% of observers viewing pictures at all parts of the system would rate the Picture Quality as "Fine".

<u>Minimum Acceptable Quality</u>

70% of observers connected at all parts of the system would rate the Picture Quality as "Fine".

Transmission objectives for the three quality grades are summarized in the following tabulation. As stated before, only the Better Quality system should be considered for ETV usage.

Transmission Design Objectives
12 Channel CATV System
0-4 Mc

	Better Quality	Good Quality	Minimum Acceptable Quality
(1) Signal to Noise Ratio (SNR), db	45	38	34
(2) Cross Modulation Index, db	52	49	48
(3) Subscribers Signal Level, dbmv	0 to 10 dbmv at 75 ohms . . .		
(4) Echo Rating, db	-34	-34	-34
(5) Radiation	FCC Sec. 15, Para. 15.161-5 .		
(6) Hum, db	-60	-50	-40
(7) Gain Stability			
Short Term, db	± 0.5	not specified	
Long Term, db	± 4.0	not specified	
(8) Differential Gain, db	± 2.0	not specified	
(9) Differential Phase	± 3°	not specified	

It is known that very few systems operate within the limit of 0 to 10 dbmv at the subscriber's terminals. Even Bell telephone service frequently operates with levels from -3 to +17 dbmv. We feel, however, that the 0 to 10 dbmv limit is a valid criterion for ETV service and that it should be met.

A wide variety of high quality CATV amplifiers and cable are now available. It is important to realize that any well designed system today is a careful balance between total expected system length and system cost. A system designed to have ten miles of cable at minimum cost, cannot be extended without either complete redesign, or a degradation of performance at the end. Therefore, it is imperative that both the ultimate system length and quality at the most distant terminus be established before any detail design or construction begins.

In Michigan, CATV service is confined principally to the Upper Peninsula with scattered systems in the Central Peninsula and Muskegon area.

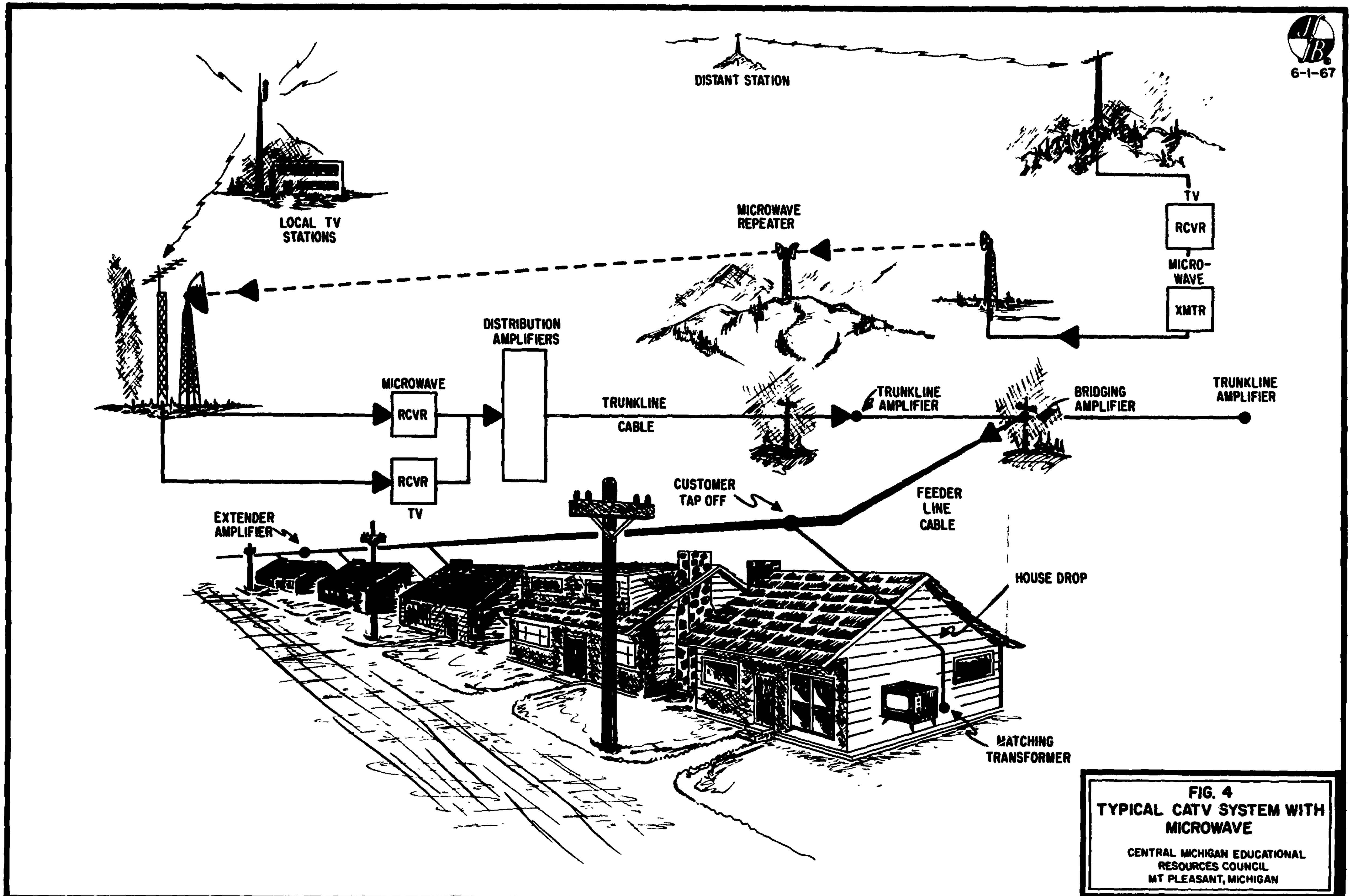

FIG. 4
TYPICAL CATV SYSTEM WITH MICROWAVE

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APPENDIX H

DATA SERVICE

APPENDIX H

DATA SERVICE

Why Data Transmission

School systems should be designed so that each individual school will contribute something to and be a part of the total system. If the schools are not to be cut off from one another, they must communicate. Many new developments in education are involving the use of machines for teaching assistance. Machines tend to become more efficient if they are large and heavily used. To avoid the disadvantages of centralization there must be easy communications between the points of use and the central location of the machine. An example of this is the library which is, in a sense, a machine and is becoming more like one with its development into a center of educational resources with records, tapes and films available as well as books. The probable upgrading of all instruction will mean that the small outlying school will be most in need of additional resources and should be among the first to call upon teaching machines, computer and recorded material. It will be at the larger schools and regional centers where much of this material will be available. It must therefore be communicated.

Data communications is today a dynamic and rapidly expanding field stimulated by the increasing need to link electronic computers and other business machines across great distances. The resultant union of the data processor and the communicator has provided a vital service to the everyday operation of business, industry and government.

Less than one percent of the computers in service today are interconnected through a communications network. However, it is estimated that ten years from now at least half of the computers in operation will be working together on a real-time basis. The volume of digital data transmitted over communications facilities will eventually equal and perhaps exceed the volume of voice traffic.

A little over a century ago the first data message was transmitted on wire lines by Morse Code. But this was not the beginning of the realization that the spoken word could be represented by some analogous language. Ancient records confirm that semaphore-type data or information transmission systems using the visual sense for perception existed even before the Greek and Roman empires.

But what is data? It might be described as factual information required as the basis for making decisions. Thus, statistical reports, engineering documents, and historical records all contain data. Data covers a broad range of information and plays an important part in the decision-making processes of our everyday lives. In this discussion, however, the meaning of data is limited to digital forms of information used in machine-to-machine communication.

The economics of computers and other types of business machines are based on moving information to achieve optimum use of what are usually expensive facilities. Some of the large-scale computers now in service are capable of input rates as high as 10,000,000 bits per second (b/s). Bit, a contraction of binary digit, expresses a unit of information in two-element binary code. The elements are called "mark" and "space," and indicate the choice between two equally possible events.

The requirement for data communications arises because modern business machines and computers can record and store information more efficiently, more accurately, and significantly faster than can humans. At present, thousands of data messages are transmitted over telephone networks at speeds many times faster than could be achieved by human speech.

As a problem solver, the computer has no peers. As a school teacher, a role its creators see as a major one in years ahead, it still has a lot to learn. One company, Responsive Environments Corporation, markets McGraw Edison's "Talking Typewriters." Under a $1-million federal grant, REC this year had 20 of the $40,000 machines in use under laboratory conditions at a Brooklyn, New York center. Another 10 were under trial in Chicago's Project Breakthrough program. REC has also stepped outside federally supported programs, having sold machines to state-financed programs, including two recently to California for use in Berkeley schools.

For most of CAI, results are not clear cut. Next year--as this year--U. S. Office of Education funds will again go into classroom experimentation with the fledgling systems. The first U. S. trial of CAI on the mass basis with unselected students will begin this fall when the Philadelphia Public School District starts "Project Grow" using a centralized processor, four remote computers, and 48 television keyboard student terminals to serve 500 students in four Philadelphia high schools. An even larger project starts next February in New York City. RCA equipment will drill 6,000 students from the first through sixth grades in reading, spelling, and arithmetic.

Most important for the future of CAI is the so-called software problem; the question of what to teach and how best to teach it. Neither responsible educators nor CAI companies profess to have all, or even many, of the answers--yet. Both shudder to recall the "Mickey Mouse era" of the mid-1950's, when countless "teaching machines" were rushed to market, and found to be only as good as their software, which was generally not very good and not very plentiful. Injured educators felt they had been taken in by fast talking salesmen. To avoid a similar and much more expensive fiasco with multimilliondollar CAI systems, educators and industrial technologists are working together to lick the software problem and bring CAI to full flower. USOE is helping with regional get-togethers.

Apart from its software problems, CAI has a serious cost problem. With computer terminal consoles currently costing an average of $2,000 each, equipping the nation's one million schoolrooms could run to $2-billion, exclusive of equally costly software.

The infantile state of CAI in the public schools, of course, does not reflect on the computer's other attainments in education. As a learning tool, the computer is making giant strides on university campuses from MIT to the University of California especially in the fields of science, engineering, and economics applications.

The market, indeed, has barely been tapped. The President's Science Advisory Committee estimates only 5% of college-level students yet have access to computers, while at least 75% could use them to advantage. It urges colleges to be spending $400 million a year on them five years from now. The U. S. campus thus is a prime target of the computer makers.

Communicating With Data

Data signals are transmitted over various types of telephone circuits. They travel on wire from telephone pole to telephone pole, through underground cables, from mountain top to mountain top over microwave facilities, on the ocean floor in submarine cables, and via communications satellites from continent to continent. Some type of data conversion equipment is required to change the digital machine signals to a form suitable for transmission over these facilities.

The data machine which provides an input to the transmit section of the conversion equipment, or modulator, can be a keyboard, printer, card reader, paper tape terminal, computer, or magnetic tape terminal. The output from the receive section of the converter, or demodulator, can be applied to a tape punch, printer, card punch, magnetic tape unit, computer, or visual display terminal. Typically, both the modulator and demodulator sections of the converter are combined into a two-way data transmitter-receiver, commonly called a data modem or data set.

Figure 5 illustrates a typical full-duplex data transmission system including the originating data processing equipment and the interface assembly which consists of buffer and control units. The interface assembly at the transmitter accepts data at a rate determined by the operating speed of the data processor, stores the data temporarily, and regenerates it at a rate compatible with that of the data modem. At the receiving terminal the interface assembly accepts the received data, stores it, then feeds it to the data processor at the appropriate rate.

Timing signals from the interface assembly at the transmitter are applied to the data modem to synchronize the computer and the data set At the receiver, synchronization pulses are derived from the data stream to synchronize the computer.

Distribution of computer power through wall outlets much like ordinary electric outlets has already become a reality at some large corporations. Special outlets are installed in offices so that those who want computer help need only wheel a special typewriter console to their offices and plug it in. An automatic switching system, such as it used for telephoning, immediately senses the request for service and connects the console to a large central computer

Researchers use a special, easy-to-learn language called Joss to instruct the time-shared computer which can handle many users at one time.

When more than one data set feeds into a computer, the capacity of the interface equipment is of major concern since it must determine the time slot allocation for each line. Various types of interface assemblies are employed, such as magnetic core memories, shift registers, and delay lines. Not all data communications terminals employ an interface between the data processor and the data modem. Without an interface the input, data transmission, and output functions proceed simultaneously and at the same rate of speed. (See Figure 6.)

Since data signals are rarely in suitable form for transmission over the various types of transmission facilities, a signal coding process is normally performed. Ideally, the transmission medium should have linear attenuation and delay characteristics, but this is never so in practice, and transmission impairments are always present to disturb the data signals. As a comparison, in voice communications a high degree of transmission irregularities can be tolerated. If a voice circuit has a heavy loss or is noisy, the speakers compensate automatically by increasing the intensity of their voices. If words are missed because of transmission difficulties, they are often understood anyway because of the redundant nature of speech. In contrast, there is no inherent redundancy in data signals unless purposely inserted and, therefore, transmission variations can only be compensated for over a very small range. In addition, data signals are sensitive to other transmission impairments which have little effect on speech.

Coding is undertaken to alleviate transmission irregularities, to increase the information capacity of the system, to enable error detection, and to provide message security. The coding process in the data transmitter (usually called encoding) simply rearranges the applied data machine signals into some other format. At the receiving end the

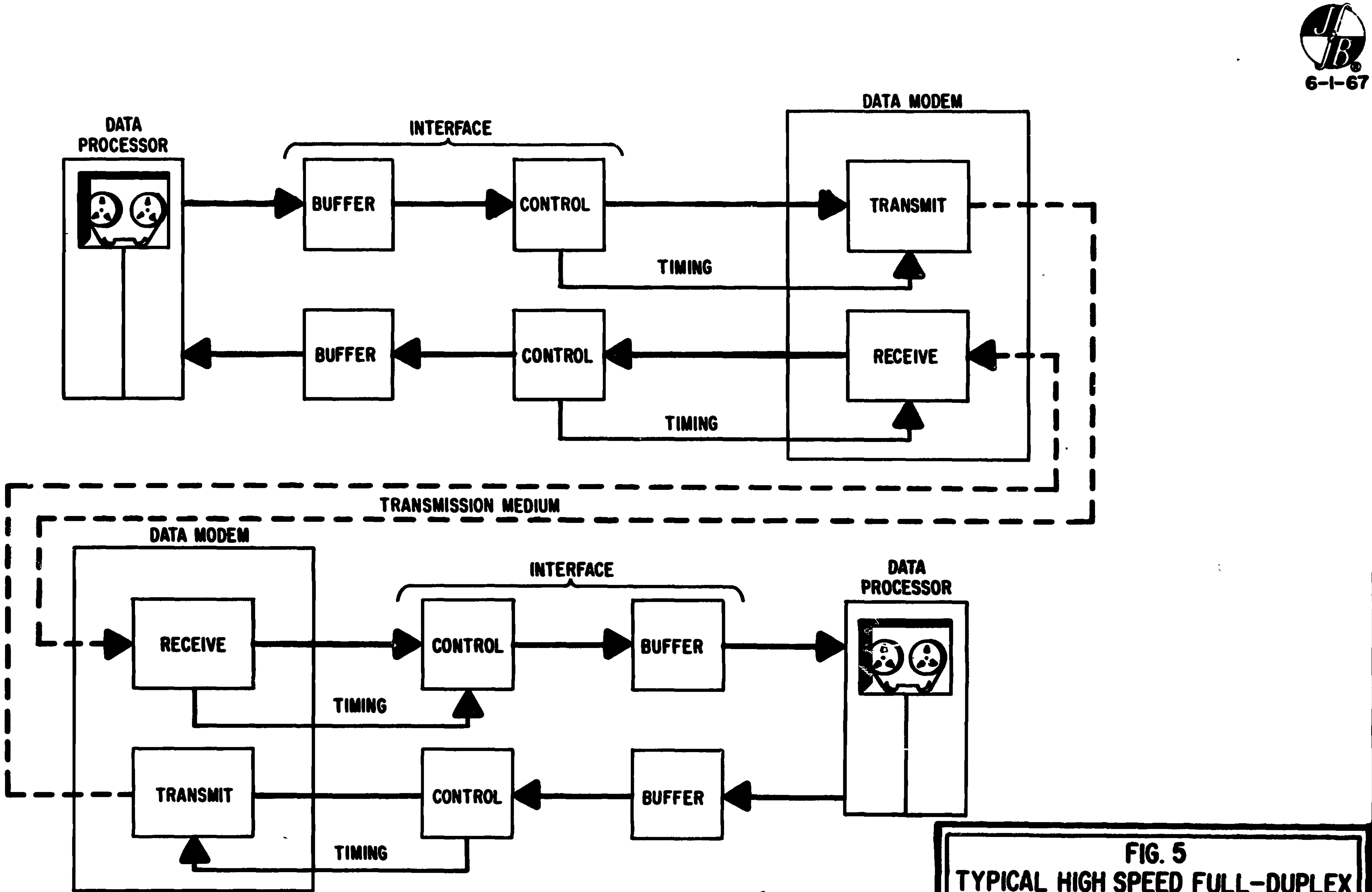

FIG. 5
TYPICAL HIGH SPEED FULL-DUPLEX DATA TRANSMISSION SYSTEM
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reverse process (decoding) is performed to recover the original machine signals.

When data communications developed, a long established voice transmission facility already existed, and logically included service to those locations that would be the terminal ends of a data communications network. To provide economical data communications service, consideration must be given to using existing transmission facilities. It would be financially impractical to establish a completely new data communications network where existing voice facilities could satisfy the need.

An example of the use of voice facilities is the "time sharing" of a computer by several users for different purposes. Although the computer serves each user in sequence, it appears that all users are handled simultaneously because of the high-speed of the computer. A typical time sharing system uses a keyboard printer to connect to a remote computer via a data set. Eventually, data transmission over voice facilities might allow the automatic payment of bills, ordering of groceries, and a variety of other household tasks.

There are times when the nature of the data to be transmitted may prevent using normal voice facilities because of such factors as speed, quality, and compatibility. In this case, the use of a microwave wideband communications facility or a narrow band telegraph channel--but not a voice channel--might be required. At present, however, telegraph and public telephone line facilities are most commonly used for data transmission because of their wide availability and economy.

Data generated at such speeds that transmission requires part or all of a 3 kHz voice channel is normally referred to as voice-band data. Within this classification, data rates of 200 bits per second or less are called low-speed data. Data rates from 2,000 to 2,400 bits per second are referred to as high-speed. Between the two, data is called medium speed.

Data signals at speeds requiring more bandwidth than a single voice channel are called wideband. The most populat use of wideband data terminals is for remote access in real time to high-speed digital computers. Many of the present wideband data communications systems operate with 48- and 240- kHz bandwidths, which are the group and supergroup allocations of common multiplex systems. These multi-voice channel allocations may be used for regular voice traffic during busy periods, and during normally slack times used as a single wideband channel for data transmission.

Because cost and not speed ordinarily determines what type of system can be used efficiently, data rates within the voice-band and wide-band classifications can vary to a broad extent. Why produce a highly complex and expensive wideband data set when an economical lower speed system will serve equally well? There are over 160 different types of data sets now being manufactured. These operate with approximately 16 different transmission dodes, at least 12 different transmission speeds, and numerous methods of error detection and correction.

Transmitting Information

During the past fifty years several investigations have been made concerning the theoretical digital signal capacities of communications channels. In the late 1920's, H. Nyquist, a mathematician at Bell's Telephone Laboratories, established a relationship between the bandwidth of an ideal rectangular distortionless communications channel and the speed of digital transmission. (Rectangular refers to the bandpass characteristic of a channel--linear throughout the band, with sharp attenuation at the ends.) Nyquist showed that the signalling rate in bits per second is equal to twice the bandwidth in Hertz of a lowpass ideal rectangular channel. For example, using Nyquist's criterion, the normal 3,000-Hz bandwidth telephone transmission channel could handle a maximum of 6,000 bics per second. However, it was realized that the distortionless conditions laid down by Nyquist were ideal and could not be achieved in practice.

Later, C.E. Shannon, then at Bell Telephone Laboratories, examined how much information a channel of given bandwidth would pass in the presence of noise. Shannon's analysis yields a rate of nearly 30,000 b/s for an average telephone channel with a good signal-to-noise ratio. Shannon did not provide a practical means of achieving such transmission capacity, and Nyquist's rate has not been attained in modern data communications. In contrast to the idealized rectangular model of Nyquist, the actual physical channels are not rectangular but have gradual cutoff characteristics and, therefore, require about twice the Nyquist bandwidth, or approximately 1 hertz per bit for optimum binary transmission.

Bits and Bauds

The speed of signalling, measured in terms of the amount of information transmitted per unit time, depends on the transmission path and its associated apparatus. Bits per second expresses the total number of information pulses in one second and includes redundant bits used for checking errors. If the pulses are of varying length, or if start and stop pulses between each character are added that are not part of the message, the bit rate tells nothing of their number or duration. On the other hand, baud--from Jean Maurice Emile Baudot, an officer in the French Telegraph Service who contributed to early telegraph principles--is defined as the reciprocal of the time of the shortest signal element in a character. The term baud is often misinterpreted as a synonym for bits per second. However, the number of bauds equals the number of bits per second only when all time intervals are constant, and all signal pulses are information pulses, such as in binary transmission.

An example of the relationship between bits and bauds is in ordinary teletypewriter transmission, which makes use of a five-bit code, each bit being 13.5 milliseconds in length The baud rate is therefore the reciprocal of 13.5 milliseconds, or approximately 74.2 bauds. A single character consists of a start pulse and the five information pulses or bits, each of 13.5 milliseconds duration, for a total of 81 milliseconds. A stop pulse of 19 milliseconds ends the character. The total time for a character is then 100 milliseconds.

Since the bit speed depends on the number of information pulses transmitted per unit of time, the equivalent rate for this type of transmission is 5/100 ms, or 50 bits per second

Now, if a lapse period of 20 milliseconds is arbitrarily inserted between the stop pulse of this character and the start pulse of the next, the bit rate would be reduced to $\frac{5}{100 \text{ ms} + 20 \text{ ms}}$ or 41.7 bits per second However, the teletype speed would remain at 74.2 bauds, because the baud rate depends only on the time length of the shortest pulse (13 5 milliseconds) in the character.

The number of words per minute can be determined using the ordinary telegraph definition of a word, which is 6 characters The speed in bits per second is converted into bits per minute by multiplying by 60; hence, 50 bits per second equals 3,000 bits per minute Since there are 5 bits per character and 6 characters per word, there is a total of 30 bits per word. Dividing 3,000 bits per minute by 30 bits per word equals 100 words per minute Here again, the transmission rate in words per minute could be reduced by a slow teletypewriter operator, but the signal speed remains at 74 2 bauds.

It can be concluded that the baud rate is very important to the telephone engineer, since this rate establishes the type of telecommunications channel to be used To a lesser degree the computer engineer is concerned with baud rate, but economics and speed of information flow are uppermost in this technology Hence, to him the bit rate is the major concern, and is the more common expression used in dealing with binary data transmission

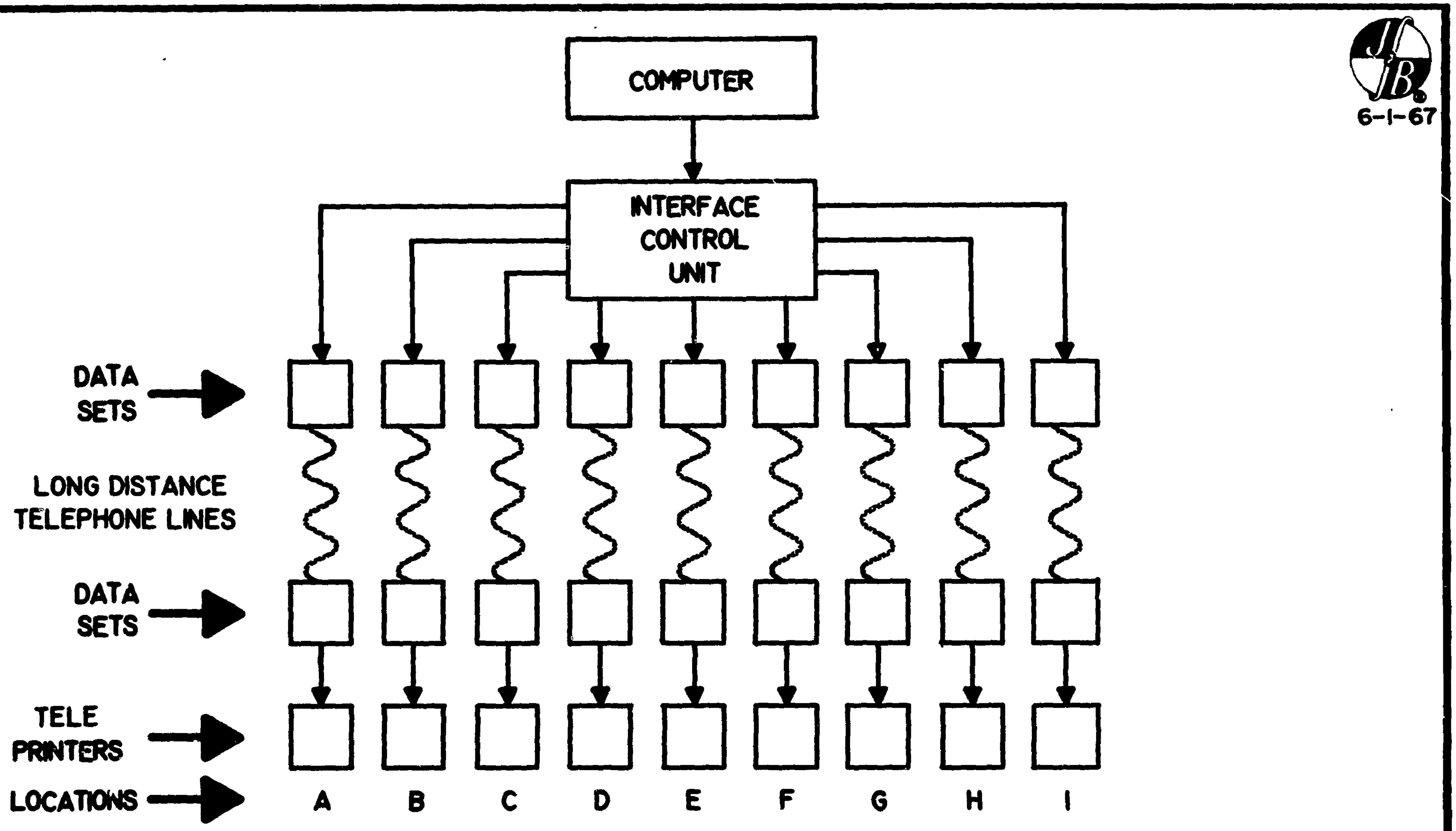

FIG. 6
A TYPICAL TIME-SHARING COMPUTER ARRANGEMENT
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Serial and Parallel Data

The terms serial and parallel are often used in descriptions of data transmission techniques. Both refer to the method by which information is processed. Serial indicates that the information is handles sequentially, similar to a group of soldiers marching in single file. In parallel transmission the information is divided into characters, words, or blocks which are transmitted simultaneously. This could be compared to a platoon of soldiers marching in ranks.

The output of a common type of business machine is on eight-level punched paper tape, or eight bits of data at a time on eight separate outputs. Each parallel set of eight bits comprises a character, and the output is referred to as parallel but bit, serial by character. The choice of either serial or parallel data transmission depends, of course, on the customer's data processing equipment and the transmission speed requirements.

Business machines with parallel outputs, however, can use either direct parallel data transmission or serial transmission, with the addition of a parallel-to-serial converter at the interface point of the business machine and the serial data transmitter. Similarly, another converter at the receiving terminal must change the serial data back to the parallel format.

Both serial and parallel data transmission systems have inherent advantages which are somewhat different. Parallel transmission requires that parts of the available bandwidth be used as guard bands for separating each of the parallel channels, whereas serial transmission systems can use the entire linear portion of the available band to transmit data. On the other hand, parallel systems are convenient to use because many business machines have parallel inputs and outputs. Though a serial data set has the added converters for parallel interface, the parallel transmitter requires several oscillators and filters to generate the frequencies for multiplexing each of the side-by-side channels and, hence, is more susceptible to frequency error

Standards

Because of the wide variety of data communications and computer equipment available, industrial standards have been established to provide operating compatibility These standards have evolved as a result of the coordination between manufacturers of communications equipment and the manufacturers of data processing equipment. Of course, it is to a manufacturer's advantage to provide equipment that is universally acceptable. It is also certainly apparent that without standardization intersystem compatibility would be almost impossible

Organizations currently involved in uniting the data communications and computer fields are the CCITT, Electronic Industries Association (EIA), American Standards Association (ASA), and IEEE.

A generally accepted standard issued by the EIA, RS-232-B, defines the characteristics of binary data signals, and provides a standard interface for control signals between data processing terminal equipment and data communications equipment As more and more data communications systems are developed, and additional ways are found to use them, the importance of standards will become even more significant

Switching Systems

In any communications system where more than two points are connected, it is necessary to have some kind of switching arrangement to connect the lines between the correct terminal points There are two types, line switching and message switching, in common use today.

Line switching is type with which we are familiar from the telephone A number is dialed which sets up a circuit connecting transmitter and receiver It is then possible to pass messages directly until the circuit is disconnected This is useful for two way conversations if the cicuit is duplex or half-duplex.

> Note: A duplex circuit is one capable of handling two messages at once, one in each direction. A half-duplex circuit can handle only one message at a time, but it may travel in either direction.

Line switching methods have the disadvantage that they tie up circuits for long periods especially on such occasions as when people are waiting to connect a group together for a conference call.

The alternative to line switching is message switching. In this the message is sent to a central point. The message is then read for instructions as to further action and sent on when a circuit is free. Thus there is never any direct connection between sender and receiver. The switching unit can also receive a message slowly from a narrower bandwidth channel and pass it over the wide band width trunk routes more quickly or vice versa. Thus full advantage may be taken of the wide bandwidth parts of a system. It is often useful to install a computer at the central location to handle the data processing needs of a number of terminals. It may then not only handle the data processing but also message switching.

The simplest type of system is where messages are received at the switching center in the form of perforated tape from a teletypewriter. An operator looks at them, tears them off and carries them by hand to the appropriate machine to send them on. In a refinement of this the operator merely has to punch buttons after looking at the tape rather than walking around with it in his hand. There are further refinements. It is possible to put a code on the front of the message which will describe the route to the switching machine so that it can punch its own buttons. On the latest machines, even this is not necessary. As long as the address code is included the machine will choose a route. When switching centers reach this complexity, it is relatively easy to add equipment to perform various auxiliary functions such as logging of traffic or addition or deletion of parts of the message.

Terminal Equipment

When data handling systems are set up there is a tendency to think of it as a sophisticated form of maid service and to regard the fact that messages have to be converted to electrical signals en route as a nuisance rather than an asset In fact it is often convenient to receive data in a form different from that in which it was sent; for example, information sent from a punched card may be most conveniently received, not as another punched card, but rather as a display of writing on the television type cathode ray tube

The commonest types of input are the teletypewriters. They accept signals directly from the typewriter keyboard or from perforated tape with a small attachment. Larger units provide inputs from punched cards or from data recorded as pulses on a magnetic tape. Most computers may be operated directly into a private telephone but for the use of the public dial telephone service, they must be connected through a Dataphone which is an ordinary telephone with an extra device that accepts data inputs and converts them to a tone code type of signal.

Receiving equipment corresponds to transmitting equipment with outputs in all the various forms Teleprinters may be fitted with a device known as a "stunt box" which is controlled by a code sequence of characters in the message. This can be used for such things as tabulation, to omit parts of the message at some receivers, and other special operations that may be required.

APPENDIX I

AN EDUCATIONAL FM SYSTEM FOR THE CENTRAL MICHIGAN REGION

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AN EDUCATIONAL FM SYSTEM FOR THE CENTRAL MICHIGAN REGION

FM BROADCAST SERVICE

I. Introduction

The establishment of a network of FM stations in the Central Michigan region would provide an educational FM broadcast service, with capability for stereophonic and Subsidiary Communications Authorization (SCA) services. Stereophonic programs are transmitted by FM broadcast stations using the main channel and a stereophonic subchannel. Auxiliary programs can be in addition on SCA subchannels for selected segment listener on a "closed circuit" basis.

II. Regulatory Aspects -- General Allocations Developments

On July 5, 1961, the Federal Communications Commission (FCC) instituted an inquiry into the over-all revision of the FM Broadcast Station Rules and Technical Standards. In its latest Notice of Inquiry in this same Docket No. 14185, issued November 14, 1966, the FCC indicated that all matters discussed in the original Notice had been disposed of with the exception of rules governing the 20 educational FM channels (channels 201 through 220, 88.1 through 91.9MHz). In this proceeding which has now been under way for over five years there are still a number of unresolved matters relating to FM utilization. Primary among these are matters which are still outstanding with respect to Canadian FM band allocation desires and the lack of final signal propagation curves for use in FM allocation pattern development. The latter curves are still under consideration by the FCC in relation to corollary FM and TV standards proceedings.

In addition to the factors set forth by the FCC in severla successive Notices, the expressions regarding Educational FM in its Annual Reports for 1964 and 1965 are of interest.

1964: "Educational FM"

> "The number of noncommercial educational FM stations continued to grow slowly, gaining 19 during the year to make a total of 257. Such stations are now authorized in 41 of the 50 states, the District of Columbia, and Puerto Rico."
>
> "Powers of stations in this service range from a low of 10 watts to a high of 523 kilowatts, the latter power being authorized to WIPR-FM, San Juan, P. R."

1965: "Educational FM"

> "Revision of the noncommercial educational FM Broadcast rules as contemplated in Docket 14185 has not as yet been completed. Consideration has been given to adopting a table of educational FM channel assignments. However, it is difficult to predict where the demand for stations will exist or what should be appropriate limits on facilities for different educational needs. Furthermore, the problem of preventing interference to TV stations on channel 6 (82 to 88Mc.) from FM stations in the adjacent educational FM band (88 to 92 Mc.) is a difficult one. In the past it has been necessary to move some educational FM stations to channels in the commercial portion of the FM band (92 to 108 Mc.) to eliminate interference.
>
> "In the meantime, the processing of applications for the educational FM band continues on a case-by-case consideration, on the basis of protecting the 1 millivolt-per-meter contour of other stations in this band and mileage separations between stations on the top three educational channels and the lower three commercial channels."

FM BROADCAST SERVICE (continued)

Further comments were submitted in Docket 14185 on April 14, 1967 and reply comments in the matter of revision of FM broadcast rules were submitted and received on May 1, 1967. All of the above relevant and timely comments and reply comments will be considered by the commission before final action is taken in this proceeding. A decision is possible in Docket 14185 within approximately a year. Meanwhile, the total number of educational FM stations has now grown to 316 of which 158 are 10 - watt stations.

III - Existing Educational FM Stations in Michigan

There are now total of 16 educational FM stations in the State of Michigan, four of which are operating in the commercial FM band. The existing FM stations with their operating parameters are listed below in Table X.

TABLE X

Channel No.	Channel Freq. (MHz)	Call Letters	City	License	Operating Parameter: Radiated Power	Operating Parameter: Antenna Height (AAT)
1	88.1 (D)	WVAC	Adrian	Adrian College	10 w	74 ft.
19	91.7 (E)	WUOM	Ann Arbor	The Regents of University of Michigan	230 kw	470 ft.
70	101.9 (B)	WDET-FM	Detroit	Wayne State University	79 kw	450 ft.
14	90.9 (E)	WDTR	Detroit	Board of Education for the City of Detroit	17 kw	175 ft.
13	90.5 (E)	WKAR-FM	East Lansing	Board of Trustee of Michigan State University	125 kw	1034 ft.
36	95.1 (B)	WFBE	Flint	Flint Board of Education	3.7 kw	115 ft.
1	104.1 (B)	WVGR	Grand Rapids	The Regents of the University of Michigan	107.5 kw	600 ft.
01	88.1 (E)	WHPR	Highland Park	School District of the City of Highland Park	10 w	34 ft.

FM BROADCAST SERVICE (continued)

Channel No.	Freq. (MHz)	Call Letters	City	License	Operating Parameter: Radiated Power	Antenna Height (AAT)
202	88.3 (E)	WIAA	Interlochen	National Music Camp	115 w	350 ft.
271	102.1 (B)	WMUK	Kalamazoo	Western Michigan University	39 kw	160 ft.
211	90.1 (E)	WNMR	Marquette	Northern Michigan University	275 w	-37 ft.
211	90.1 (E)	WCMU-FM	Mt. Pleasant	Central Michigan University	10 w	52 ft.
207	89.3 (E)	WOAK	Royal Oak	The School District of the City of Royal Oak	10 w	75 ft.
207	89.3 (D)	WSAE	Spring Arbor	Spring Arbor College	10 w	60 ft.
202	88.3 (D)	WSHJ	Southfield	Board of Education of Southfield Public Schools	10 w	105 ft.
218	91.5 (D)	WPHS	Warren	Warren Consolidated Schools	10 w	129 ft.
201	88.1 (D)	WEMU	Ypsilanti	Eastern Michigan University	10 w	109 ft.

IV - Proposed Educational FM System

A. General

The opportunity to establish a regional educational FM system has been provided by the FCC in Docket No. 14185, paragraph 3, which states as follows:

> "One of our principal aims in this field is to provide for single signal coverage to as much of the population and area of the country as possible in order that the pertinent state bodies concerned with educational broadcasting can plan for state-wide networks or regional networks where feasible."

To obtain complete coverage of the Central Michigan region, at least 3 high power FM stations are required. These should be located in the vicinity of Alpena, Cadillac, and Bay City. The proposed TV station sites would be excellent for use by the FM transmitters at substantial savings

FM BROADCAST SERVICE (continued)

in cost.

There are numerous education FM channels available in the Central Michigan region and no allocation problems are foreseen. Some care should be taken not to use high powered FM transmitters on the lowest FM channels in the fringe reception areas of the proposed Alpena TV channel 6. FM transmitters have been known to cause interference to TV receivers close by.

Each proposed educational FM station should operate with transmitting equipment to provide an effective radiated power of approximately 100 kilowatts in the horizontal plane and 25 kilowatts in the vertical plane with an effective antenna height of about 900 feet. The FM station should be designed to operate with a stereophonic subchannel and with one Subsidiary Communications Authorization (SCA) subchannel service for transmitting programs on a "closed circuit" basis. The estimated capital cost for the proposed educational FM station is listed in Table XI.

1. Cadillac - Traverse City Area

The National Music Camp presently operates WIAA (FM) at Interlochen near Traverse City. This area will require a high power FM station for the regional FM system. If the National Music Camp desires to affiliate with the regional network, the station should relocate to the proposed TV tower for Channel 27. The increased height will greatly improve its coverage. If WIAA does not wish to become a part of the regional network a new station should be provided at the proposed TV site designed for a stereo system and a SCA subchannel for simultaneous programming.

2. Saginaw - Bay City Area

The FM transmitter should be located at the relocated WUCM-TV, Channel 19, site, utilizing the proposed transmitting building and tower. The FM transmitting station should be designed to operate, with an effective radiated power of 100 kilowatts in the horizontal direction

FM BROADCAST SERVICE (continued)

and 25 kilowatts in the vertical plane, with an effective antenna height of 900 feet side mounted on the proposed TV tower. The FM station should be designed for stereo and at least one SCA subchannel for simultaneous programming. The proposed FM station, should provide excellent coverage in the Bay City - Saginaw area.

3. Alpena

The FM transmitter should be located at the proposed ETV channel 6, transmitter site, thereby utilizing the ETV transmitting building and tower. The FM transmitting station should be designed to operate with an effective radiated power of 100 kilowatts in the horizontal direction and 25 kilowatts in the vertical plane with an effective antenna height of 900 feet. The FM station, also should be designed for a stereo and a SCA subchannel for simultaneous programming.

TABLE XI

ESTIMATED CAPITAL COSTS FOR FM STATION

(100 kw. Horizontal and 25 Kw. Vertical ERP at 900 ft. AAT)

Quantity	Equipment	Cost
1	20-kilowatt FM transmitter complete, including filter	$25,000
1 set	Spare tubes complete including spare crystals	1,500
1	FM stereo and SCA subcarrier generators complete including filters	4,000
1 set	Transmitter input and monitoring equipment	8,500
1	Antenna, 8-bay horizontal and 4-bay vertical including power divider	8,000
1000 ft.	3-1/8 inch transmission line (including hangers, elbows, etc)	10,750
1	Line pressurizing equipment	1,500
Misc.	Hardware adaptors, fittings, clamps, connectors, and gassing accessories	2,000
1 set	Test equipment	2,000
--	Installation, legal and engineering, freight	8,500
--	Contingencies	9,000
	Total	$80,750

APPENDIX J

COLOR TELEVISION

APPENDIX J

COLOR TELEVISION

The question of color television is bound to arise in any discussion about a statewide educational telecommunications system. Color has become a regular part of the commercial broadcast service and the average home-owner has the major portion of the broadcast day not available to him in color programming. Educational broadcasting, instructional television, and closed circuit television of all sorts will in time also utilize color programming. In fact, many educational stations are broadcasting today part of their programs in color. NET is presently building its library of color tape recording.

Color television in the U.S. went through considerable technical evolution and standardization during the mid 1950's. After several false starts, the NTSC system was finally adopted as the broadcasting standard, and now all TV broadcast stations must use this standard. It is called a compatible standard in that a conventional black and white television receiver can accept a quality picture even though it is transmitted in color. Likewise, a color receiver will automatically produce color on receipt of a color signal and a black and white picture if a monochrome picture is being transmitted. Some compromise in the resolution of the picture has been necessary in order to accomodate the additional color information. However, this is not considered to be a serious drawback for normal home viewing on conventional sets. It is however, somewhat of a drawback for critical viewers or in critical viewing circumstances such as might be encountered with medical television, special closed circuit applications, and even in some instructional applications. In these instances the standards would not need to apply if the color signals are not broadcast or the regular TV channels. For the home viewer, the classroom receiver, and most applications for regular broadcast receivers, color can be a valuable addition to the system performance. Perhaps equally important is that a transmitting system adjusted for color will produce better picture on monochrome transmission that

COLOR TELEVISION (continued)

would the same system were it not adjusted for color.

In Michigan most all of the commercial TV stations carry substantial portions of their broadcast day in color programming from the networks. The cost of adapting a broadcast TV station to carry network programs is minor. Any broadcast transmitting system that is adjusted to carry good monochrome pictures can, with very minor changes, carry a color program. For these reasons, we strongly recommend that all the broadcast ETV transmitters proposed in this report be fully adapted and adjusted to carry color programming.

Color program origination equipment (color cameras etc) is nearly prohibitive for most instructional and educational broadcasters. Cost comparisions are made of monochrome U. S. color in the listing of studio equipment in Appendix dealing specifically with studio costs and it is evident that the cost of color program origination is approximately 50 per cent higher than the cost of the same programming in black and white. The equipment is more expensive, the cost of producing programs is more expensive. More time is needed in lighting, set design, rehersals, and adjustment of equipment to produce quality color than is required for similar quality black and white. We feel that color will have a real and vital place in educational television, but it will not be until better techniques and lower operating costs are evolved in our technology. We are not recommending the compromising of quality for the sake of saving a questionable amount of money. Present day color equipment is expensive because it is very sophisticated complex equipment requiring considerable design know-how and manpower to assemble. Until more technological breakthroughs have been achieved to simplify camera equipment without compromising its technical performance, we believe color will have limited usage in education.

Up to now we have been discussing primarily broadcast application of color television. Many collegiate level schools, particularly medical

COLOR TELEVISION (continued)

and dental schools, have utilized color television for certain instructional portions of their curriculum and in general has played a vital and meaningful role in the expansion of medical training centers. We believe that closed circuit color television will continue to grow as a significant user of color programming. The present NTSC systems of encoding is the one most frequently today. Critical viewing requiring accurate rendering of subtle shades and hues, such as in tissue analysis or unusually fine definition applications, can be accommodated by color television. However, a different means of transmitting the color picture should be used rather than the conventional NTSC system. The NTSC system is only a convenient technique whereby a basic color television picture is encoded into a compatible form whereby black and white and color receivers can both receive an acceptable quality picture. Where only color monitors are to be used, no encoding is needed and the basic red-green-blue primary colors are used just as they are resolved within the color camera. Each individual application should be carefully analyzed to determine both the fidelity of reproduction that is required and the costs that might be involved in the proposed technique. Suffice to say here that closed circuit is not restricted to the limitations imposed by the NTSC encoding system.

The relationship between the U. S. standard NTSC color system and the other encoded color systems commonly used throughout the world bears some comment. There are two other encoded systems color in general usage, both having a strong resemblance to the NTSC system but with minor changes to adapt them to the particular scanning standards used in that country. For instance, Western Europe uses a system called PAL which is very close to NTSC in its operation except that it is scaled for use on a 625 line television system scanning at 50 cycles per second rather than a 525 line system scanning at 60 cycles per second as in the U. S. The PAL and NTSC are almost identical in their performance as a

COLOR TELEVISION (continued)

viewer would see it. A third system, SECAM, has been adopted primarily by France, Russia, and portions of the Communist world, whereby the color signal is treated in a slightly different manner to permit easier transmission through microwave systems. The end result is very similar in quality to the NTSC system. Any exchange of color programming with foreign countries would have to take into account their particular scanning and color standards. The development of high quality standards converters is now being realized in Europe to permit changing from one standard to another without visible loss of picture quality. Of course, all of the North American Continent uses the U. S. standard as does Japan and most of South America.

APPENDIX K

TELEVISION TAPE RECORDING EQUIPMENT

APPENDIX K

TELEVISION TAPE RECORDING EQUIPMENT

Introduction

The magnetic tape recording industry has provided a most versatile tool to the television industry. Television, as we know it today, would be virtually impossible without some means of recording, storing, and playing back program material with ease and fidelity. Its wide use has permitted the television tape recorder to be highly specialized in various categories of service. This section illustrates those categories each machine can best serve and its important characteristics, costs, and other relevant information.

Classes of Television Tape Recorders

Present day television tape recorders may be broadly categorized into two groups in accordance with the geometric technique of applying the recorded material to the tape. The first commercial machines by the Ampex Corporation in the mid 1950's utilized a rotating recording head wheel which scanned across a 2 inch wide tape that moved longitudinally at moderate speed from one reel to another. This has commonly been called transverse scan, quadruplexed, or broadcast type recording. Suffice to say here that the quadruplex or transverse scan type machine is capable of the highest quality of video recording. New techniques called high band have recently been developed whereby color television signals may be recorded and subsequent recordings or dubs then made of the original recording and continued on to the third generation without objectionable degradation of the color picture. A high quality black and white television picture could be re-recorded up to eight or more times before the quality had deteriorated to an unacceptable level. Thus the quadruplex machine is used in those instances where the maximum quality and/or numerous re-recording is requireu, such as production centers, distribution centers, major tape libraries, etc.

The second broad category of tape recorders is commonly called the helical scan, or slant track machine. These machines got their start in the quest for a low cost, portable type unit that could be used by non-technical personnel. Recent advances in the helical scan machines have improved their reliability and quality but not to the same order of magnituue as the quadruplex type machines. When a low priced unit is developed in a market with a high demand, competition tends to generate a wide variety of competitive models. This had happened in the slant track recorder industry. There are at least 9 major manufacturers of equipment each with several models to offer a wide price and performance range. With this quanitty of competing models it has been impossible to achieve compatibility even within the various machines of the same manufacturer. At present there is no compatibility of tape between different manufacturers. There is little compatibility between various models of the same manufacturer and only a few models exist that are even compatible within a particular model line. Thus the helical tape machine industry has been close to chaos, with a great deal of misinformation supplied by the sales agents to prospective purchasers who are seldom able to make a technical evaluation or judgment.

Standardization

The quadruplex type machine has been in use in the broadcast industry for over ten years now. Its use from the very start has been standardized through the Society of Motion Picture and Television Engineers (SMPTE) and other standards associations, thus making the quadruplex equipment highly compatible between manufacturers and equipments. It is because of this standardization that major tape libraries are possible. A great deal of programming is now distributed on quadruplex video tape recordings. As new techniques and developments have occurred, the manufacturers have made their quadruplex equipment compatible with the existing standards and models, as well as the standards

TELEVISION TAPE RECORDING EQUIPMENT (continued)

encompassing the new techniques.

Standardization has not been the case in slant track machines. Because of their volume production and sales, manufacturers have had little inclination to slow down their production or to obsolete past models in order to make a compromise with their competition. This has been further complicated by the influx of many equipments from foreign manufacturers, particulary Japan. No real effort has been made by the manufacturers to be compatible with any competitive model, or even with his own past models. Some slant track equipments must play back the recording on the same machine with the same recording head as made the recording. Thus tape libraries and regional distribution become very difficult helical tape equipment.

Some effort has been made in recent years by the Slant Track Recording Sub-committee of the SMPTE in order to provide a meaningful slant track recording standard that would be acceptable within the industry. This subcommittee has met over the past two years but as of this writing, has not yet reached an agreement on any comprehensive standards. Progress has been made, but major factors must still be resolved, particularly those of a non-technical or proprietary nature of the individual company. Thus, it will be some time before meaningful standards and compatibility can be expected in the slant track industry.

Recommendations - Quadruplex Tape Recorder

The quadruplex tape recorder can be purchased for as little as $30,000 or for as much as $100,000 for a complete operating machine. Why the vast difference in price? What is the advantage of the high priced machine or what will the high priced machine do that the lower price one cannot? The following discussion will be limited to currently available models from US manufacturers. The field is essentially three manufacturers and about four models from each. Starting with the top of the line, these machines will do anything that is possible to do with a television tape recorder. For their lofty ($100,000) they provide the maximum flexibility

TELEVISION TAPE RECORDING EQUIPMENT (continued)

in operation, permit recording and re-recording (dubbing), represent the highest reliability in equipment are the most sophisticated, the fastest to operate in tight schedule situations, and the most versatile for complex program production recording.

Many machines now utilize a recording technique developed in recent years called "high band". In essence this is a technique whereby a wider bandwidth of information may be faithfully recorded and played back from tape. This has required a very careful development of both equipment and magnetic recording tape. High band is now well proven and it is believed that most quadruplexed tape recording in the near future will be done on this standard. It is interesting to note that until high band techniques were developed, color television signals could not be accurately recorded on <u>any</u> tape machine. The recording that was played back did not, in reality, comply with all of the broadcast requirements imposed by the FCC, although this fact was conveniently ignored by broadcasters and manufacturers alike. Any system or station planning to use color recording equipment should utilize high band television recorders.

A medium priced, more compact and somewhat less versatile quadruplex machine is available from most manufacturers that will also accommodate the high band color recording for prices up to the mid $60,000. These machines are entirely adequate for routine non-complicated recording and playing back of program material and general station use.

The quadruplex tape machine can be purchased for as little as $35,000. These equipments are stripped down versions and generally do not have the capability for high band color. As a result, we see little use for these equipments except in those locations that do not intend to carry color programs. The industry is turning sharply towards color and soon virtually all programming will be done in color. Tape recorded programs will, of necessity, be in the high band standard. Thus the stripped down units, unless they are capable of easy and inexpensive conversion to high band, would seem to have a limited place in tomorrow's television.

TELEVISION TAPE RECORDING EQUIPMENT (continued)

Additional features are available as accessories on most quadruplex machines. These include special editing, slow motion, automatic "drop out", and timing devices. Most can be added when and if the need arises.

Recommendations - Slant Track Tape Recorders

The wide assortment of slant track machines poses a thorny problem for the non-technical person who must decide where or how these machines should be used. In general, the slant track machines are low in price and operable by a non-technical person in a very short time, thus making them readily adaptable to the "user" operation. This would include the classroom, the individual school, or possibly even the school district which desired to record program material. Time scheduling, slow motion replay, or repeated playback for more advantageous study, are typical applications for the slant track recorders. This is not to say that all user applications should be slant track, but rather it should be the users option to utilize slant track, if it will indeed meet his requirements. Certain medical and collegiate level instruction has not been adaptable or able to utilize slant track machines. These must obviously still be handled on the higher quality quadruplex machines.

Slant track machines should rarely require any copies to be made of the original recording. Thus tape library information would have to be stored in the original recording. Copies or dubs are not generally satisfactory from slant track equipment unless maintenance and operating procedures are of the very highest caliber. Some collegiate level instructional studios started their recording on slant track machines, but gave it up and switched entirely to quadruplex because of the inability of the slant track machines to be maintained in reliable condition for continual use (60 - 80 hours per week).

Be cautious in the purchase of slant track equipment. Endeavor to be certain of your use of the machine, the need for copies or dubs, and the caliber of personnel that will operate it. In general, non-technical personnel can achieve a satisfactory recording and play back from all

TELEVISION TAPE RECORDING EQUIPMENT (continued)

of the slant track machines if dubing is not attempted. Some slant track machines are claimed to be able to record color programs. We have not seen yet a passible demonstration of this capability but we believe that it probably will be achieved in the next year or two. Standardization for slant track color is even further away.

Summary

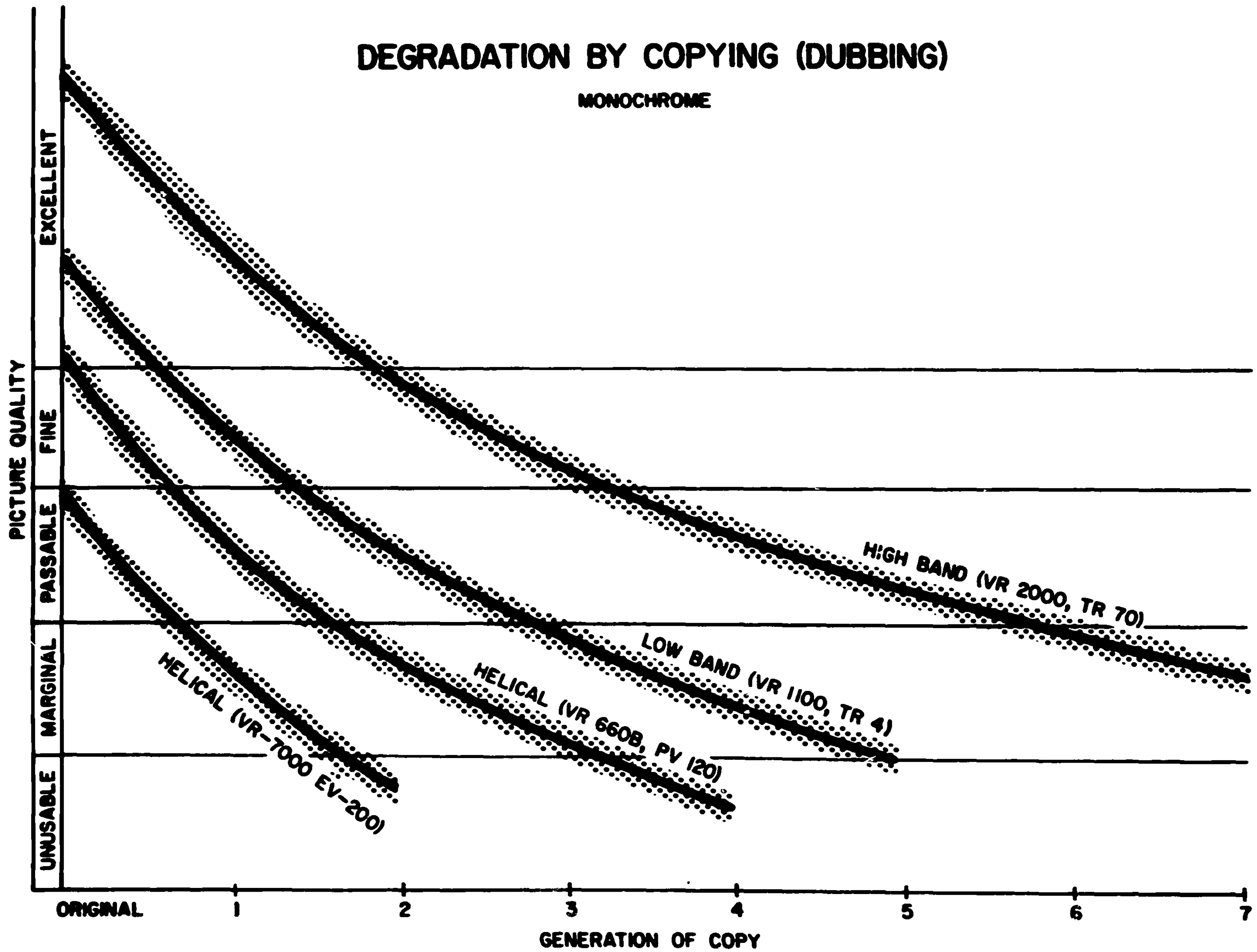
The quadruplex machines utilize a magnetic tape two inches wide moving at a rate of 7 1/2 or 15 inches per second. The equipment is highly sophisticated including elaborate mechanisms to compensate for recording and operating errors. Cost of such equipment range from the $30,000 to $100,000. We recommend careful consideration of those equipments which utilize the newer technique called "high band" recording in order to take full advantage of a reproduction of color television signals. Of course these expensive types of equipment have a great deal of versatility and can accomplish many complex production and recording marvels. Their ability to record and re-record program material successfully without visible loss of quality is a distinct advantage in the preparation of present day television programs.

The slant track recorders are generally of much lower price, ranging from the $1500 to $8,000. They have sharply reduced size and weight; to that of a large suitcase. These reductions have generally been at the expense of versatility, performance and compatibility. This is not to condemn these machines. They have a distinct place in the educational television and other fields by reason of their ease of operation and low cost. We recommend that they be confined, at present, to "user" oriented services rather then in the distribution or production of program material.

FIG. 7
CHARACTERISTICS OF TYPICAL
VIDEO TAPE RECORDERS

DEGRADATION BY COPYING (DUBBING)

MONOCHROME



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APPENDIX L

TYPICAL COSTS FOR STUDIO PRODUCTION FACILITIES

APPENDIX L

TYPICAL COSTS FOR STUDIO PRODUCTION FACILITIES

Studio Production Equipment

A typical studio will be equipped with two professional live cameras, one film camera, film and slide projection equipment, audio, and auxiliary control equipment, test equipment, and a basic studio lighting package. Other technical supplies such as spare lamps, tubes, parts, shop tools, etc., are not included since these are usually made a part of the operating expenses. A spare parts and equipment pool could be developed for a network system. This would offer the advantage of stockpile sharing and avoidance of extensive duplication of technical supplies.

The following list contains recommended minimum technical equipment for use at a production studio. Development of program resources, exchange, and usage will require periodic additions and changes. Also, more complex production requirements and schedules can sharply increase these costs.

Typical Television Studio Equipment Costs
for Quality Classroom Instructional Type Programs

Quantity	Equipment	Cost	
	Control Room Equipment - Video	Monochrome	Color
1	Studio switcher, including monitor, console housing, regular and non-additive mixing, and power supply	$ 7,000	$ 12,000
1	Studio intercom, including camera telephone, and interphone connection unit.	800	800
	Sync generator	3,000	4,000
	Distribution amplifiers (video)	1,300	2,000
	Continuity monitors - 17 inch	1,400	5,400
	Cabinet racks	720	1,200
	Miscellaneous items, including cable, connectors, and special hardware, etc.	3,500	7,000
	Total	$ 17,720	$ 32,400

Quantity	Equipment	Cost	
	Control-Room Equipment - Audio	Monochrome	Color
1	Control consolette with power supply	$ 2,500	$ 2,500
1	Turntable (12") with tone and arm and preamplifier	300	300
1	Monitoring speaker and enclosure	150	150
4	Intercom speakers	50	50
2	Lapel microphones	175	175
1	Boom microphone	235	235
1	Boom microphone stand	450	450
2	Desk microphones and stands	330	330
1	Tape recorder (audio)	1,600	1,600
	Miscellaneous audio equipment	2,500	2,500
	Total	$ 8,290	$ 8,290

Film Equipment

Quantity	Equipment	Cost	
	Film Equipment		
1	Vidicon film camera with lens, remote control panel, master monitor, power supply, and console housing	$ 10,000	$ 50,000
1	Vidicon multiplexer	2,200	5,000
2	16 mm film projectors with lenses and accessories	24,800	24,800
1	Television slide projector	4,500	4,500
1	Projector remote control panel	250	1,200
	Film storage cabinets	480	480

Quantity	Equipment	Cost Monochrome	Cost Color
	Film Equipment		
	Assorted reels, bulk leader, rewind set, splicer, timer, viewer, film cement, etc.	900	900
	Total	$ 43,130	$ 86,880
	Studio Cameras		
2	Studio camera image orthicon type with 50-foot camera cable, zoom lens, view finder, all tubes, camera control, picture and waveform monitors, control housing and power supplies	$ 44,000	$160,000
2	Camera heads	$ 2,000	8,000
2	Camera pedestals	4,400	7,000
4	50-foot camera cables	900	2,500
	Total	$ 51,300	$177,500
	Studio Lighting Equipment		
	(Note: Quartz lamps are to be encouraged)		
16	300/500 watt baby scoops, 15-inch	$ 640	$ 640
16	750/2,500 watt, 18-inch scoops	750	750
16	500/750 watt Fresnel spots, 6-inch	580	580
8	1,000/2,000 watt Fresnel spots, 8-inch	580	580
4	500/750 watt Kliegl, 6-inch with iris	320	320
4	500/750 watt Kliegl, 6-inch	250	250
	Accessories for scoops and spots, including diffusers, barn doors, caster stands, extension cables, and counterbalances	2,000	2,000

Quantity	Equipment	Cost Monochrome	Cost Color
4	Portable connector strips with five, 4-foot pigtails and 20 feet of cable	800	800
4	Portable connector strips with five 4-foot pigtails and 25 feet of cable	800	800
4	Portable connector strips with five, 4-foot pigtails and 35 feet of cable	900	900
5	Location feeder boxes, 60-amp. circuit and switch, assorted lamps	1,000	1,000
	Total	$ 8,620	$ 8,620
	Studio Test Equipment		
	Partial Allowance (33%)	$ 3,090	$ 3,090
	Installation and Test		
	Includes equipment placement, wiring, lighting grid assembly, and testing	$ 15,000	$ 15,000
	Contingencies		
	Miscellaneous auxiliary equipment as required	$ 15,000	$ 15,000
	Total	$162,150	$346,780

Estimated Cost of Video Tape Recording Equipment

Quantity	Equipment	Cost Monochrome	Cost Color
2	Quadruplex television tape recorder, transistorized with monitoring accessories	$136,000	$190,000
1	Tape splicer	1,250	1,250
2	Spare headwheel panel assembly	4,000	4,000

Quantity	Equipment	Cost	
		Monochrome	Color
2	Remote control panel	$ 900	$ 900
	Tape recorder test equipment	9,000	9,000
	Total	$151,150	$205,150
	Studio Equipment	162,150	346,780
	Studio Building (5,500 ft.)	165,000	165,000
	GRAND TOTAL	$478,300	$716,930

SUMMARY

CAPITAL COST FOR BASIC TELEVISION STUDIO

	Monochrome	Color
Building space - 5,500 sq. ft. for one 50' x 40' studio, related work areas, electric service, and air conditioning. Estimated @ $30 per square foot:	$ 165,000	$ 165,000
Control room equipment - video	17,720	32,400
Control room equipment - audio	8,290	8,290
Film equipment	43,130	86,880
Video tape recorders	151,150	205,150
Studio cameras	51,300	177,500
Lighting equipment	8,620	8,620
Test equipment (partial)	3,090	3,090
Installation and test	15,000	15,000
Miscellaneous and contingent	15,000	15,000
One studio-total	$ 478,300	$ 716,930

APPENDIX M

RECOMMENDED TECHNICAL STANDARDS

APPENDIX M

RECOMMENDED TECHNICAL STANDARDS

General

The Technical Standards recommended for use in the State of Michigan for educational television network exchange must encompass all the Standards provided in Part 73 of the Federal Communication Commission's Rules and Regulations which provide the basic scanning details inherent in the broadcast television transmission system used on the North American Continent. Use of other scanning standards for broadcasting is not permitted in the United States except under experimental license by the Federal Communications Commission. Additional standards are detailed for each portion of the television system.

Before any equipment is contracted by competitive bid, the specifications and detailed system plans should be carefully developed by a competent independent consulting engineer. Such specifications, when properly prepared, will facilitate the evaluation of the bids received and will insure that equipment to be supplied will fit the needs and requirements of the system. Further, the engineer should oversee the equipment installation and certify that the system of equipment as installed actually meets the specifications.

Transmitter Equipment

Each television transmitter (broadcast or ITFS) and its associated terminal equipment participating in the Michigan Educational Television System must be designed and maintained so as to meet the performance specifications detailed in the Electronic Industries Association (formerly RETMA) publications TR-104-B and RS-222. The following additional requirements should be a part of each transmitting station:

1. The amplitude versus frequency characteristics of the visual transmitter shall be maintained within the limits of ±1 db between the frequencies of 0.5 and 4.0 megacycles.

2. The envelope delay of the transmission system, including the input equipment to the transmitter, the transmitter, and antenna system, shall present an over-all envelope delay within 75 percent of the tolerance prescribed in Section 73.687 (a) (5) of the Federal Communications Commission's Rules and Regulations.

3. Maximum differential gain expressed in decibels relative to the maximum gain at 50 percent average picture level (APL) shall not exceed 0.5 db and shall not exceed 0.8 db at 10 and 90 percent APL. All such measurements shall have reference white at 87.5 percent modulation on the transmitter.

4. The differential phase, as measured in the same manner at levels as in the above Paragraph 3, shall not exceed five degrees.

5. The voltage standing wave ratio (VSWR) on the normally connected transmitter transmission lines and antenna shall be maintained at 1.08 or better at visual carrier and 1.15 or better at aural carrier.

6. DC pulse measurement on each line shall show no undue discontinuities in the transmission line or elbows due to the presence of installation defects.

7. RF pulse measurements at the visual carrier frequency having a pulse width of 0.25 microsecond shall be fed into the antenna system at the output of the diplexer. The relative reflected voltage, as measured at the antenna input shall be 30 db or greater below the amplitude of the initial pulse. The VSWR and RF pulse requirements shall be met simultaneously.

8. Wind load ratings of all towers shall be consistent with EIA recommendations.

It is expected that all transmitters shall be equipped with suitable phase and frequency compensation networks to handle color signals adequately. Although color studio equipment may be some years away for most ETV locations, color programs will be available to it from numerous outside sources. Consequently, it is vital that the network interconnection system as proposed herein be able to handle color signals without equipment modifications.

Studio Equipment

Video amplifiers shall have a pass band of 1.0 cycle to 8 megacycles ±0.25 db and 0.5 cycle to 10 megacycles ±1 db. The K factor for sin-squared test pulse shall be less than 1%. Sending end terminations shall be used on all video transmission lines.

Film equipment shall utilize vidicon cameras equipped with suitable automatic sensitivity, black level, and gain control units to maintain the proper balance between film density and vidicon sensitivity. Professional 16 mm projectors shall be used in all cases. Projector maintenance shall be performed by personnel recommended by the equipment manufacturer. The vidicon camera shall resolve at least 350 television lines* at the picture center, at least 300 lines at the corners of the picture, and the 10 shades of grey from a calibrated EIA test pattern slide shall be clearly discernible.

All live cameras shall be of the image-orthicon type except where production requirements could better be served by the characteristics of the professional photo conductive type camera. All cameras shall have attached view finders and multiple lens turrets. Variable focal length lenses may be substituted where production needs would be served better by such lenses. Control units shall include a master monitor (high quality picture and waveform presentation) for each camera. Picture orbiting equipment shall be standard on all image-orthicon cameras. Live cameras shall resolve at least 350 television lines at 100 percent amplitude at the picture center and at least 250

* For definition and methods of determination, see IRE Standard 60IRE23.S2

lines (at 100 percent amplitude) at the corners of the picture. Cameras equipped with new pickup tubes will be expected to be considerably better. All cameras shall respond to the 10 shades of grey on the EIA standard test pattern at normal light levels.

Control room wiring and layout shall be such that at least 50 db isolation is maintained between desired and all other undesired signal sources for frequencies from DC to 10 megacycles. Video tape recorder equipment shall be quadruplex type maintained according to the current recommended techniques of the equipment manufacturer. High band operation, frame and line lock accessories shall be included in all playback machines.

All studio audio equipment shall conform to the EIA RS-219 Standards for Audio Facilities for Radio Broadcast Systems. All power supplies, audio amplifiers, video amplifiers, switching equipment, sync generators, and pulse distribution amplifiers shall be entirely solid state in design. Cameras, monitors, and transmitters shall use solid state circuitry insofar as practical with the state-of-the-art.

CABLE TELEVISION DISTRIBUTION

The following is intended to provide guidelines for the installation and performance of cable television distribution systems operated by or for school systems.

These guidelines are not intended to be completely rigid. Because of constantly changing product lines, new usages for television service, and the trend toward more stringent standards for transmission systems of this type, periodic revisions will be required.

Definitions

Video Distribution - Coaxial cable, amplifiers, and fittings for distribution of signals in the band of frequencies from 2.0 Hz to 10.0 MHz. Standard level - (luminance) 140 IRE Units composite video (1.0 Volt peak to peak across 75.0 ohms)

RF Distribution - Coaxial cable, amplifiers and fittings for signals in band of frequencies 5.0 MHz to 250 MHz. Standard level +20 dbmV (10.0 millivolts across 75.0 ohms).

Audio Distribution - Shielded or unshielded twisted pairs of wire, terminal strips, amplifiers, and fittings for signals in band of frequencies from DC to 100 KHz. Standard level - +8VU (6.3 milliwatts into 600 ohms).

Head End Equipment - Antennas, converters, receivers, masts, coaxial cable, amplifiers, and accessories to receive and process "off the air" TV signals prior to distribution within the building.

Talk-Back Circuit - A voice quality telephone type circuit to permit spoken communications between the classroom user and the program origination point.

Entertainment TV - TV Programming for entertainment, general cultural enrichment, current events, news, and general interest non-credit instruction. This programming is typically available from standard commercial and educational broadcast TV stations, and is normally distributed within buildings on RF distribution systems with or without channel conversion.

Instructional TV (ITV) - TV programming especially prepared and distributed for controlled usage in classrooms for instruction of students, in formal courses for credit.

Technical Performance - RF Distribution Systems Exclusive of Head End Origination, and RF Modulation Equipment

All cable shall be sweep frequency tested from both ends by the manufacturer. No cable shall be installed having a Structural Return Loss (SRL) of less than 30 db for any frequency from 5 MHz to 250 MHz.

All cable runs in excess of 50 feet shall be sweep frequency tested from both ends after installation by the contractor. The SRL shall be at least 24 db from 5 MHz to 250 MHz. (VSWR 1.135).

All cable shall be of the type specified.

At the output jack for the classroom receiver, the visual carrier level (peak of sync) shall not be less than 3.0 mv (4.5 dbmV) nor more than 10 mv (+20 dbmV) as measured across 75 ohms. Aural carrier level shall be at least 7 db but not more than 15 db below peak visual carrier.

The undesired aural carrier of the lower adjacent channel shall be at least 10 db below the desired peak visual carrier.

The frequency response of the RF distribution system as measured at any output to a receiver shall be ±5 db of the level output of 108 MHz. The response across any 6 MHz TV channel shall be ±1.0 db of the level at the respective channel visual carrier. The level of visual carriers separated by 6 MHz shall not differ by more than 1.0 db.

These performance specifications shall be met in outdoor temperatures from -50 to +130° F and with power line supply voltages from 105 to 130 volts. Normal indoor temperatures shall prevail.

Isolation between any two sets shall be at least 35 db. Isolation between any set and its feeder line shall be at least 20 db.

All classroom receivers shall be equipped for 75 ohm input of RF signal. Any impedance matching transformers shall be internal to the set.

Cross modulation, intermodulation products, and spurious signals generated within the distribution system between any two or more modulated or CW carriers shall be at least 50 db below peak visual carrier in any 6 MHz TV channel.

All AC hum and hum products shall not exceed 2% amplitude modulation of any RF signal.

The visual carrier to thermal noise ratio (peak of sync to rms noise) shall not be less than 50 db at a 4 MHz bandwidth.

The system shall distribute simultaneously without degradation, interference, or interaction, the standard TV Channels 2 through 13, and the standard FM band. Unless specified otherwise, the passband of all RF distribution amplifiers, cable, taps, splitters, combiners and other active and passive elements of the distribution system shall be from 50 MHz to 250 MHz.

GENERAL RECOMMENDATION FOR COAXIAL CABLE IN CLOSED CIRCUIT ETV
June 1966

A. For general studio and control room video usage: Belden 8281, WE 724, or equal -

Double shielded (low crosstalk)
Accurate and uniform impedance
Stable characteristics
Connector fittings are available
Small diameter

B. For long runs of video or RF in conduit: Belden 8213, or equal (Foam type RG 11)

Low loss (55% of 8281) at 10 MHz
Cable must be preswept over frequency range to be used
Not recommended for video usage in control room areas - (excessive crosstalk)

C. For long runs on messenger cable: Andrew FH-4, Jerrold JT-1500, or equal (1/2" Alum. Foam)

Low loss
Uniform (if preswept)
Stable characteristics
Negligible RF leakage
Available in continuous lengths up to 2500 feet
NOTE - Cannot be put in a conduit with bends.

D. All connectors should be compression sleeve type solderless fittings.

E. Not Recommended:

RG-59/U: - High loss, not of uniform impedance, center conductor tends to migrate.

RG-11/U: - Same as above.

All solder type connectors to outer braid - Solder temperature melts polyethylene permitting dislocation of center conductor.

Microwave

Regional and statewide ETV microwave networks must be of compatible design and capability in order to interconnect intra-state and interstate. Two primary requirements are:

1. An NTSC color signal may be transmitted over a system of 100 such microwave links.
2. Within the state (15 to 20 hops), the system is capable of relaying wideband TV or the use of separate information channels above the video when required.

Common carriers may utilize these requirements for their consideration in establishing the required tariffs to provide this new service. Carriers should bear in mind that this system will:

1. Cross state lines.
2. Have IF switching inserts under the direct control of the user.
3. Have the base band loading under the direct control of the user (assuming frequency and amplitude limits would be met.)
4. Interconnect to and with other state systems utilizing unknown carriers and tariffs. No restriction shall be placed on such interconnection provided it is done on user premises.

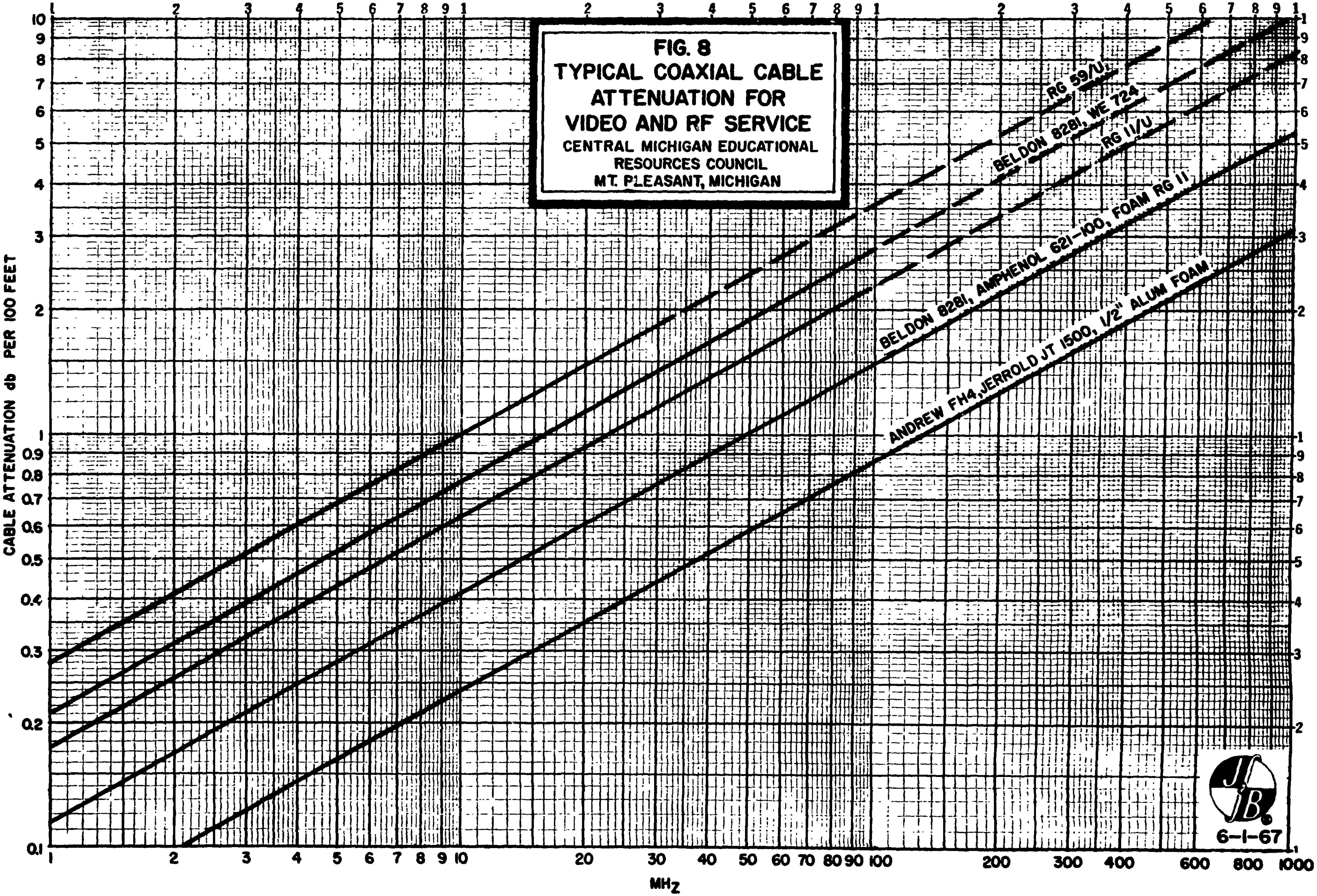


FIG. 8
TYPICAL COAXIAL CABLE
ATTENUATION FOR
VIDEO AND RF SERVICE
CENTRAL MICHIGAN EDUCATIONAL
RESOURCES COUNCIL
MT. PLEASANT, MICHIGAN
RG 59/U
BELDON 8281, WE 724
RG 11/U
BELDON 8281, AMPHENOL 621-100, FOAM RG 11
ANDREW FH4, JERROLD JT 1500, 1/2" ALUM FOAM
CABLE ATTENUATION db PER 100 FEET
MHz
6-1-67
2 X 3 CYCLE

PERFORMANCE SPECIFICATIONS
HYPOTHETICAL SYSTEM

Item	100-hop Section Approx. (2600 mi.)	Single CCIR Section 20-hops (Approx. 520 mi.)
System Gain	±0.65 db	±0.25 db
Gain Stability		
Short term (1 sec.)	±0.3 db	±0.25 db
Long term (1 hr.)	±1.3 db	±0.5 db
Continuous Random Noise (Video) 1/		
S/N (P-P/RMS) weighted	54 db	60 db
Frequency Response (Baseband) 2/		
1 kc.to 4.5 mc.	±2.2 db	± 0.5 db
1 kc. to 8.5 mc.	----	± 1.0 db
Hum		
S/hum (P-P/RMS) unclamped	43 db	50 db
Single Frequency Noise 3/		
S/I (P-P/P-P) 1 kc. to 2 mc.	57 db	64 db
Linear decrease from 2 to 4.5 mc.	41 db	48 db
Linear decrease from 4.5 to 7 mc.	--	40 db
Differential Gain (3.6 mc.) 4/		
50% APL	1.0 db	0.3 db
10% - 90% APL	1.5 db	0.5 db

1/ For footnote references see page 3

Item	100-hop Section (Approx. 2600 mi.)	Single CCIR Section 20-hops (Approx. 520 mi.)
Differential Phase (3.6 mc) /5/		
50% APL	±2.0°	±0.7
10% - 90% APL	±3.0°	±1.0°
Low Frequency Square Wave Response 6/		
60 cps square wave tilt or bulge (unclamped)	±5%	±2%
60 cps square wave tilt or bulge (clamped)	1%	1%
Sin^2 Pulse and Half-Line Bar 6/		
K Factor	3%	1%
Audio Frequency Response		
60 cps to 8 kc.	±2.5 db	±1.0 db
Total Harmonic Distortion		
60 cps to 8 kc.	2.5%	1.5%
Audio Signal-to-Noise Ratio		
(RMS/RMS)	53 db	55 db

Path Engineering shall provide a propagation reliability in excess of 99.99 per cent for each hop. Under faded conditions a signal-to-noise ratio less than 33 db (weighted) shall be considered unusable.

Equipment shall be operated by DC power supplied by a charger-regulator and battery combination to provide an eight-hour battery reserve at unmanned sites and a two-hour reserve at manned sites in the event of an AC power failure. All microwave RF repeaters shall be IF heterodyne type.

Notes Concerning Measurement of Listed Parameters

1. Measurements of continuous random noise will be made according to recommended procedures of EIA RS-250-A.

2. The frequency response from 60 cps to 1 kc is usually assisted by clamp circuits. In the absence of clamping, which would be the case when transmitting data, the low frequency response must be compensated accordingly. The frequency response shall be measured by a constant amplitude sine wave or by a swept frequency method in which the composite synchronization wave form and the test signal are displayed on an oscilloscope.

3. The ratio of peak-to-peak value of interfering tone (single frequency noise) to the peak-to-peak value of desired signal shall be measured using an oscilloscope or spectrum analyzer. If a spectrum analyzer is used, RMS values will be obtained.

4. Differential Gain and Phase at 3.6 Mc shall be measured according to 60 IRE 23.S1.

5. Envelope delay shall be compensated such that it will conform to CCIR performance standards.

6. Low-frequency square-wave response and the response to a Sin^2 pulse and half-line bar shall be measured using appropriate EIA test signals and masks for evaluation of 525-line, 30-frame-per-second, nominal 4 Mc video signals.

June 1967

APPENDIX N

A GLOSSARY OF TERMS AND ABBREVIATIONS

APPENDIX N

A Glossary Of Terms & Abbreviations

AMERICAN STANDARD CODE FOR INFORMATION INTERCHANGE (ASCII) - A teletypewriter code established as an American standard by the American Standards Association for transmission of alphabetic and numerical symbols by electronic means.

AMERICAN TELEPHONE & TELEGRAPH CORPORATION (AT&T) - A communication common carrier.

AMPLIFIER - Electrical device through which a sound or picture signal is strengthened.

AUDIO - Of or concerning sound; specifically, the electrical currents representing a sound program or the sound portion of a television program.

BAND - A range of radio frequencies within two definite limits and used for a definite purpose; for example, the Standard Broadcast Band extends from 550-1600 kilohertz, television from 54-216 megahertz and international broadcasting uses several bands between 6,000 and 22,000 kilohertz.

BANDWIDTH - The range of frequencies required to convey the visual or aural information being transmitted; the Bandwidth of a television channel in the U.S. is 6 megahertz.

BASEBAND - In the process of modulation, the frequency band occupied by the aggregate of the transmitted signals when first used to modulate a carrier.

BROADCAST - Radio or television service on standard assigned frequencies available in the home on conventional receivers. Stations may be commercial or noncommercial. Open circuit.

BUFFER - A storage device used to compensate for a difference in rate of flow of data or time of occurrence of events, when transmitting computer data from one device to another.

COMMUNITY ANTENNA RELAY (CAR) - A class of Microwave relay service to provide signals for Community Antenna Television.

CAMERA CHAIN - TV camera plus electronic equipment necessary to deliver a complete picture for telecasting.

CHANNEL - A range or "band" of frequencies assigned for the transmission of communications signals; in television it is the group of frequencies comprising the transmitted visual (video) and sound (audio) signals.

CHANNEL ALLOCATION - The channel or band in the radio spectrum to which a television station is assigned, or the channel space in the radio spectrum to which a communication service is assigned.

CLOSED CIRCUIT - A private wire or radio circuit used as one means of carrying or conveying from one location to another an audio or television program for specialized audience use.

COAXIAL CABLE (concentric line) - A transmission line formed by two coaxial conductors, each insulated from the other by some suitable insulating material such as air or polyethylene, polyfoam, teflon, etc.

COMMON CARRIER - A communications company franchised to provide specialized interconnection services to the public. The telephone company is a typical example.

COMMUNICATIONS CHANNELS - Telephone, teleprinter, facsimile, data and other similar circuits with which to communicate voice or printed information. Typically voice channels having a frequency of response 300 to 3000 Hz.

COMMUNICATIONS COMMON CARRIER - A company which dedicates its facilities to a public offering of universal communication services, and which is subject to public utility regulation.

COMMUNITY ANTENNA TELEVISION (CATV) - A master antenna array and the signal distribution system, i.e., the amplifiers, antennas, coaxial cable connecting devices etc., necessary to distribute several TV signals throughout a community.

COMPATIBLE COLOR SYSTEM - A color television system which permits normal black and white reception of its transmitted signals without altering currently used receivers.

COMPUTER ASSISTED INSTRUCTION - An experimental system of instruction demonstrated by MIT to permit the student to learn at his own pace on a pre-programmed course of instruction in a share time computer.

CONVERTERS - A device to change the channel or frequency of an FM or TV signal.

DATA CHANNELS - A communications channel for handling digital type data (such as teletypewriter, digital computer), or analog data (such as "Electrowriter", facsimile, and slow scan TV).

DATA-PHONE - A trade mark of the A.T.&T. Company to identify the data sets of the Bell System for transmission of data over the regular dial telephone network.

DECIBEL - A unit expressing a power ratio. Decibel (or db) = $10 \log \frac{P_1}{P_2}$

DEMODULATION - The process of removing the video and audio signals from their respective carrier waves.

DIRECTIONAL ANTENNA - An antenna radiating or receiving radio waves more effectively in some directions than in others.

EFFECTIVE ANTENNA HEIGHT - The height of a transmitting antenna above the average level of the surrounding terrain.

EFFECTIVE RADIATED POWER - The apparent power radiated from a directional FM or television antenna. The product of the antenna power input and the antenna power gain.

ELECTRONIC BLACKBOARD - A proprietary device of the General Telephone and Electronics Company to facilitate - voice communications and a projected blackboard image between two remote locations.

ELECTROWRITER - A product of the Victor Instrument Company for reproducing handwritten messages at a remote location via a narrow-band radio or telephone circuit

FEDERAL AVIATION ADMINISTRATION (FAA) - Federal agency responsible for safe aeronautical practices in the U. S.

FACSIMILE - Any of several techniques for sending half tone, hard copy pictures by wire or radio circuits. Transmission speed is typically 2-5 minutes per picture. In a broad sense - slow scan television where the end picture is produced on paper instead of a picture tube.

FEDERAL COMMUNICATIONS COMMISSION (FCC) - The U. S. Government agency governing all radio and TV radiations in the air and to some extent, those through wire or cable.

FIDELITY - The degree to which a system, or a portion of a system, accurately reproduces at its output the essential characteristics of the signal that is impressed upon its input.

FILM - Motion picture type film. In television, this is usually standard 16 mm sound on film, although a very small amount of standard 35 mm theater type film is used at some major TV centers.

FREQUENCY - Number of cycles per second or hertz.

Hz - Hertz (Hz) - 1 cycle per second.

HARD COPY - A printed copy of machine output in readable form for human beings; for example, reports, listings, documents, summaries, pictures.

INSTRUCTIONAL TELEVISION FIXED SERVICE (ITFS) - A special closed type of ETV service to provide multiple channel distribution using frequencies from 2500 to 2690 MHz. using standard TV channel widths. Service uses low power transmitters and directional antennas having a service range of 8 - 15 miles.

INTERCONNECTION - The electronic system for connecting two or more locations for some type of communications service.

INTERFERENCE - Disturbance in radio reception caused by undesirable signals or stray currents from electrical apparatus, atmospheric static, etc.

KINESCOPE RECORDING - A sound motion picture, usually on 16 mm. film, photographed from a special television picture tube.

LONG DISTANCE XEROGRAPHY (LDX) - A name used by the Xerox Corporation to identify its high speed facsimile system. The system uses Xerox terminal equipment and a wide band data communication channel.

LIVE - Studio or on-the-spot televising of events and people, in contrast to the transmission or recorded material, such as film video tape.

MIDWEST PROGRAM ON AIRBORNE TELEVISION INSTRUCTION (MPATI) - An airborne television system using a high flying aircraft as a television transmitting site. Operations are based at Purdue University, Lafayette, Indiana.

MASTER EXCHANGE (MASTER CONTROL) - The point or points at which all TV signal assimilation occurs for subsequent scheduled distribution through a TV system; this includes control of all intercommunications signals, TV signals, etc. Sometimes called a control center.

MEGACYCLE (mc) - One million cycles; when used as a unit of frequency, it is equal to one million cycles per second. Preferred term is megahertz. (MHz)

MICROWAVE - Radio waves above UHF frequencies, generally 2,000 to 15,000 MHz. Because of their short wave length, they begin to behave as visible light.

MICROWAVE RELAYS - Systems used for transmission of video and audio signals by highly directional radio beams at frequencies between 2,000 and 15,000 MHz. Distances of typically 30 miles may be covered by a single link consisting of a transmitter and receiver; longer distances may be covered by multiple links receiving and transmitting the original signal.

MODULATION - The process of impressing audio or video impulses on the carrier wave for transmission through the air.

MONITOR - To control the picture shading and other factors involved in the transmission of both a scene and the accompanying sound. Monitoring usually occurs in the studio control room and at the transmitter. Also denotes a special type of high quality receiver.

OPEN CIRCUIT - General term applying to Broadcast Television on VHF and UHF channels. Implies the availability of reception to the public within range of the TV stations.

PRIVATE LINE OR PRIVATE WIRE - A channel or circuit furnished a subscriber for his exclusive use.

PRIVATE LINE TELEPHONE - The provision of facilities, including channel terminals, local channels and interexchange channels and station equipment, which permit oral communications between specified locations continuously at a fixed charge per month.

PRIVATE LINE TELETYPEWRITER - The provision of facilities including channel terminals, local channels and interexchange channels and station equipment, which permit the transmission of written communications between specified locations continuously at speeds of 60, 75 and 100 words per minute and 110 baud and at a fixed charge per month.

PRODUCTION STUDIO - A specially designed and equipped group of rooms for making or producing television programs from live action. Included would be the studio room, control room, storage areas, announce booth, and such offices and practice areas needed for a complete working unit.

RELAY STATION - A station used to receive picture and sound signals from a preceding station and to transmit them to another relay station or to a television broadcast transmitter.

REMOTE PICKUP - Event televised away from the studio by a mobile unit or by permanently installed equipment at the remote location.

REPEATER - A device for receiving, amplifying and re-transmitting a signal.

SATELLITE STATIONS - Broadcast stations located outside the area of service of another parent television broadcast station, licensed to the same ownership and intended primarily to repeat the same program to extend the service to an adjacent area; technical requirements are the samé as for a regular license.

SERVICE AREA - The region surrounding a broadcasting station in which that station's signals can be received with satisfactory results.

SIGNAL - Information transposed into electrical impulses. Two basic signals are involved in television transmission - the picture or video signal and the sound or audio signal. Each signal contains electrical impulses representing the elements transmitted.

SLOW-SCAN TELEVISION - Television systems capable of producing still pictures at a rate of several per minute. Image is often viewed on electronic storage picture tubes for durations up to one half hour.

SPECTRUM - The entire range of electromagnetic radiations from the longest audio waves through the range of radio communications, infra red, visible, and ultra violet lights, to the shortest known cosmic rays. See Spectrum chart at end of this section. (Figure 9).

STUDIO - Same as Production Studio.

STUDIO CONTROL ROOM - The room or location where the monitoring equipment is placed for the direction and control of a live television program.

TELELECTURE - A system for presenting audio and written material together in a single voice grade telephone circuit. Similar to "Blackboard by Wire" and "Electronic Blackboard."

TELEPRINTER - Term used to refer to the equipment used in a printing telegraph system. A teletyprewriter.

TELETYPE - Trademark of the Teletype Corporation. Usually refers to a series of different types of teleprinter equipment such as transmitters, tape punches, reperforators, page printers, utilized for communication systems.

TELETYPEWRITER - An electric typewriter responding to any of several teletype coded electric input signals.

TELETYPEWRITER EXCHANGE SERVICE (TWX) - An automatic teleprinter exchange switching service provided by the Bell System which permits the transmission of written communications between TWX subscribers at speeds of 60 and 100 words per minute. Rates are based upon distance between communicating subscribers and connection time.

TELEVISION - The radio or electrical transmission of a succession of images and their reception in such a manner as to give a substantially continuous and simultaneous reproduction of an object or scene before the eyes of a distant observer.

TELEVISION BROADCAST SIGNAL - A combination of two radio frequency carriers spaced by 4.5 MHz, the lower one being amplitude modulated by the picture signal, the upper one being frequency modulated by the accompanying audio signal.

TELEVISION CHANNEL - A band of frequencies 6 megacycles wide in which are contained all of the frequency components of a television broadcast signal. These bands are designated by number from 2 through 83.

TELEVISION RECEIVER - A receiver for converting incoming electric signals into television pictures and customarily associated sound.

TELEVISION TAPE RECORDER - An electro mechanical device for storing television program material on a magnetic tape.

TELEX - An automatic teleprinter exchange switching service provided by Western Union.

TELPAK - A broadband facility of four sizes (48, 96, 240 and 1000 KHz) used to transmit various forms of electrical communication such as telephone, teletypewriter, and data. The broadband facility may be used as a whole for high-speed data transmission or it may be used for the derivation of channels of lesser band-width such as telephone and teletypewriter. A fixed charge per month applies for each Telpak service.

TERMINAL - 1. A point at which information can enter or leave a communication network.
2. An input/output device designed to receive or send source data in an environment associated with the job to be performed and capable of transmitting entries to and obtaining output from the system of which it is a part.

TIME-SHARING - A method of operation in which a computer facility is shared by several users for different purposes at (apparently) the same time. Although the computer actually services each user in sequence, the high speed of the computer makes it appear that the users are all handled simultaneously.

TRANSMITTER - The electronic device for generating a modulated radio frequency signal at substantial powers representing a complete audio or television signal (including audio, video, and synchronizing signals).

TRANSLATOR STATION - Low power unattended repeaters intended to extend the service from an existing licensed station (ownership may be the same as the station used for program source). The channel selected for translator service is based on availability and interference considerations.

VHF - Very High Frequency, normally between 30 and 300 MHz. In television channels 2 through 13.

VIDEO - Of or concerning sight. Specifically, those electrical currents representing the elements of a television picture.

VIDEO SIGNAL - The frequencies generated by the scanning of a scene or image plus the synchronizing pulses involved.

VIDEO TAPE - A magnetic tape for recording television signals.

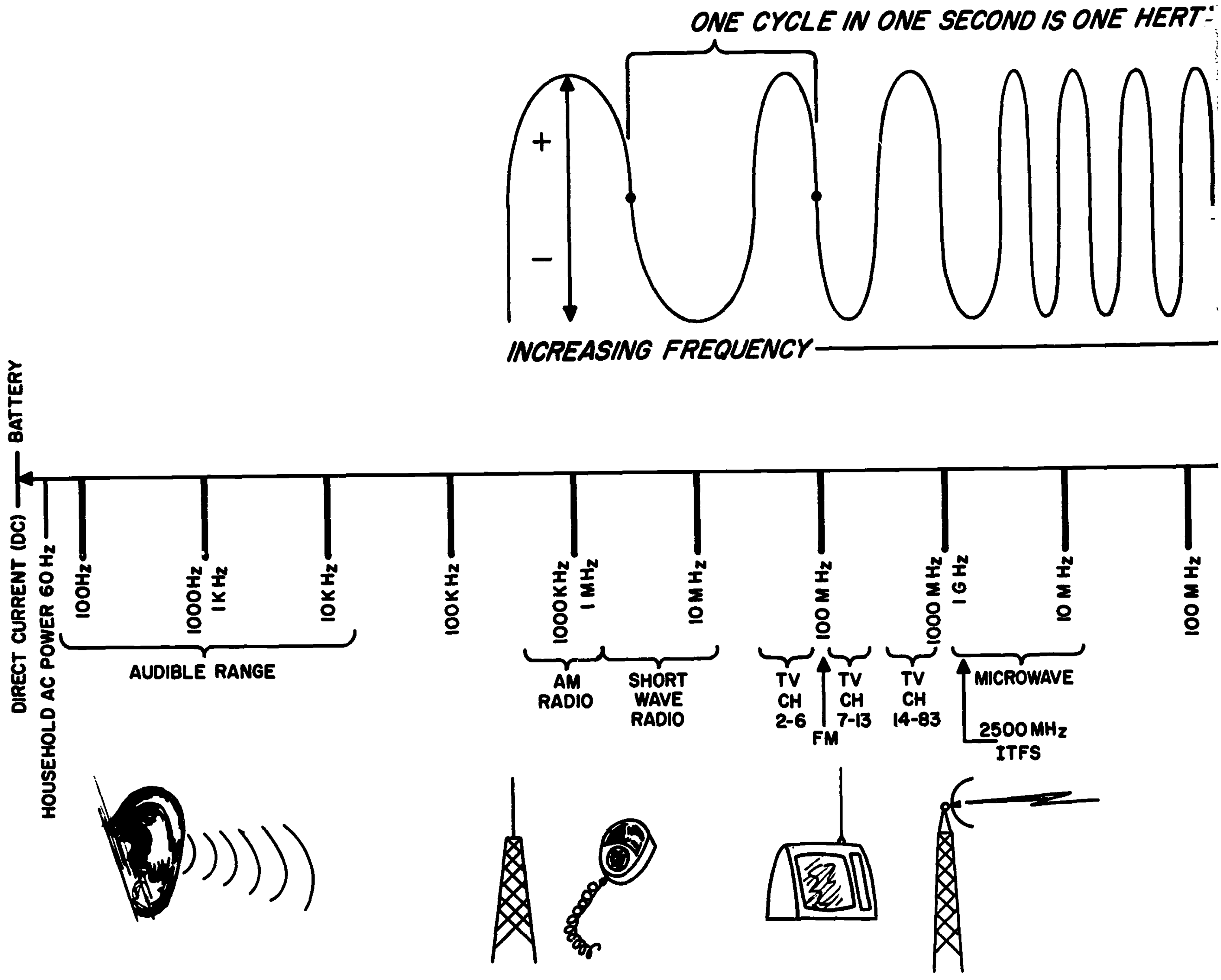
VIDEO TAPE RECORDER - Proprietory name of the Ampex Corporation for a television tape recorder.

VOICE GRADE CHANNEL (Voice Circuit) - A channel suitable for transmission of speech, digital or analog data, or facsimile, generally with a frequency range of about 300 to 3000 cycles per second.

WIDE AREA TELEPHONE SERVICE (WATS) - A service provided by Telephone Companies which permits a customer by use of an access line to make calls to telephones in a specific zone on a dial basis for a flat monthly charge.

WIDEBAND CHANNEL - A channel wider in bandwidth than a voice grade channel.

WORD - 1. In telegraphy, six characters (five characters plus one space).
2. In computing, an ordered set of characters which is the normal unit in which information may be stored, transmitted, or operated upon within a computer.



ONE CYCLE IN ONE SECOND IS ONE HERT
+
−
INCREASING FREQUENCY
BATTERY
DIRECT CURRENT (DC)
HOUSEHOLD AC POWER 60 Hz
100Hz
1000Hz
1 KHz
10 KHz
100 KHz
1000 KHz
1 MHz
10 MHz
100 MHz
1000 MHz
1 GHz
10 MHz
100 MHz
AUDIBLE RANGE
AM
RADIO
SHORT
WAVE
RADIO
TV
CH
2-6
TV
CH
7-13
FM
TV
CH
14-83
MICROWAVE
2500 MHz
ITFS

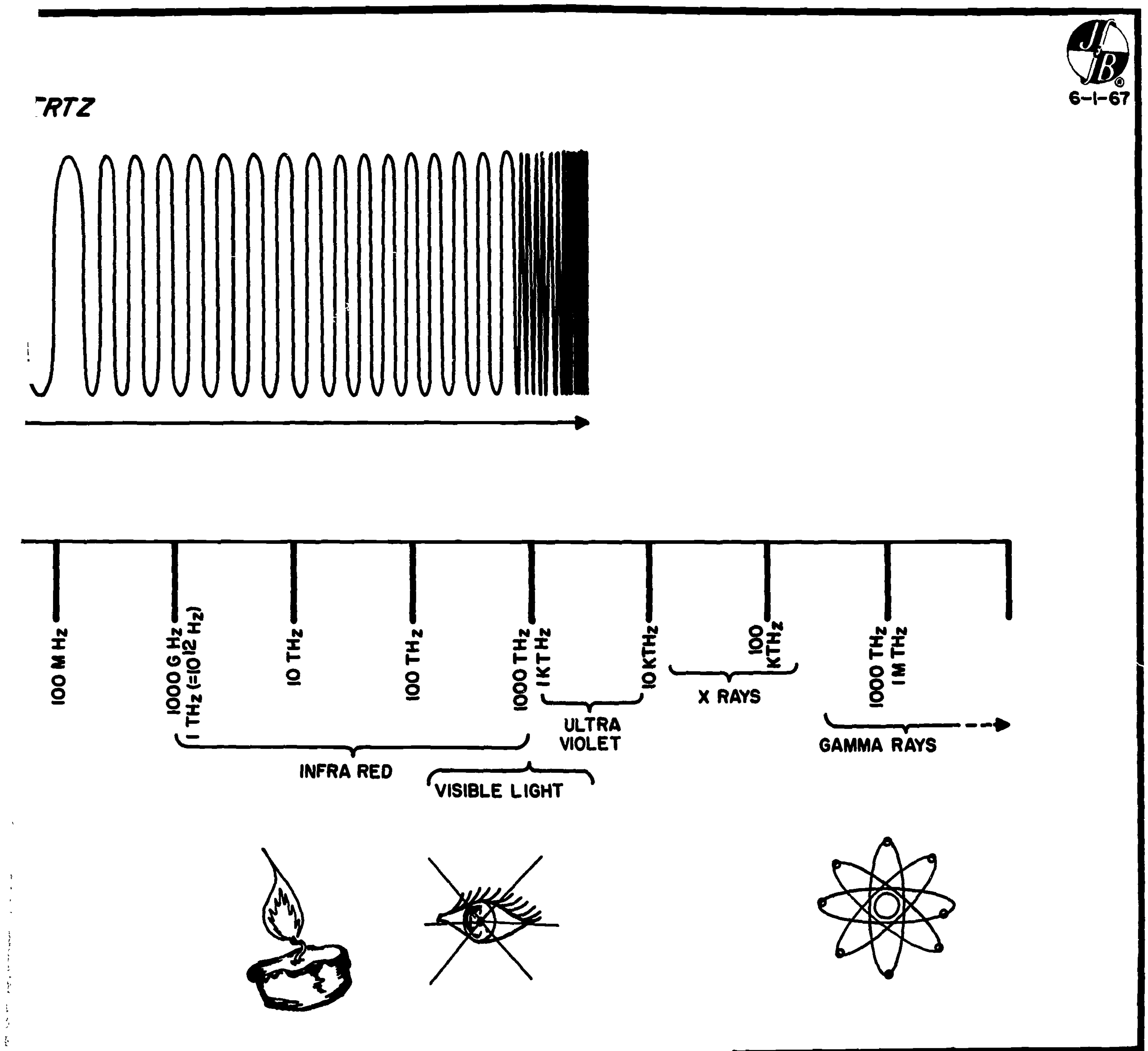


FIG. 9
ELECTROMAGNETIC SPECTRUM

CENTRAL MICHIGAN EDUCATIONAL RESOURCES COUNCIL
MT. PLEASANT, MICHIGAN

APPENDIX O

BIBLIOGRAPHY

BIBLIOGRAPHY

GENERAL

ENGINEERING AND SYSTEMS

STATE-WIDE TELEVISION PLANNING

EQUIPMENT AND STANDARDS

INSTRUCTIONAL RESEARCH

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