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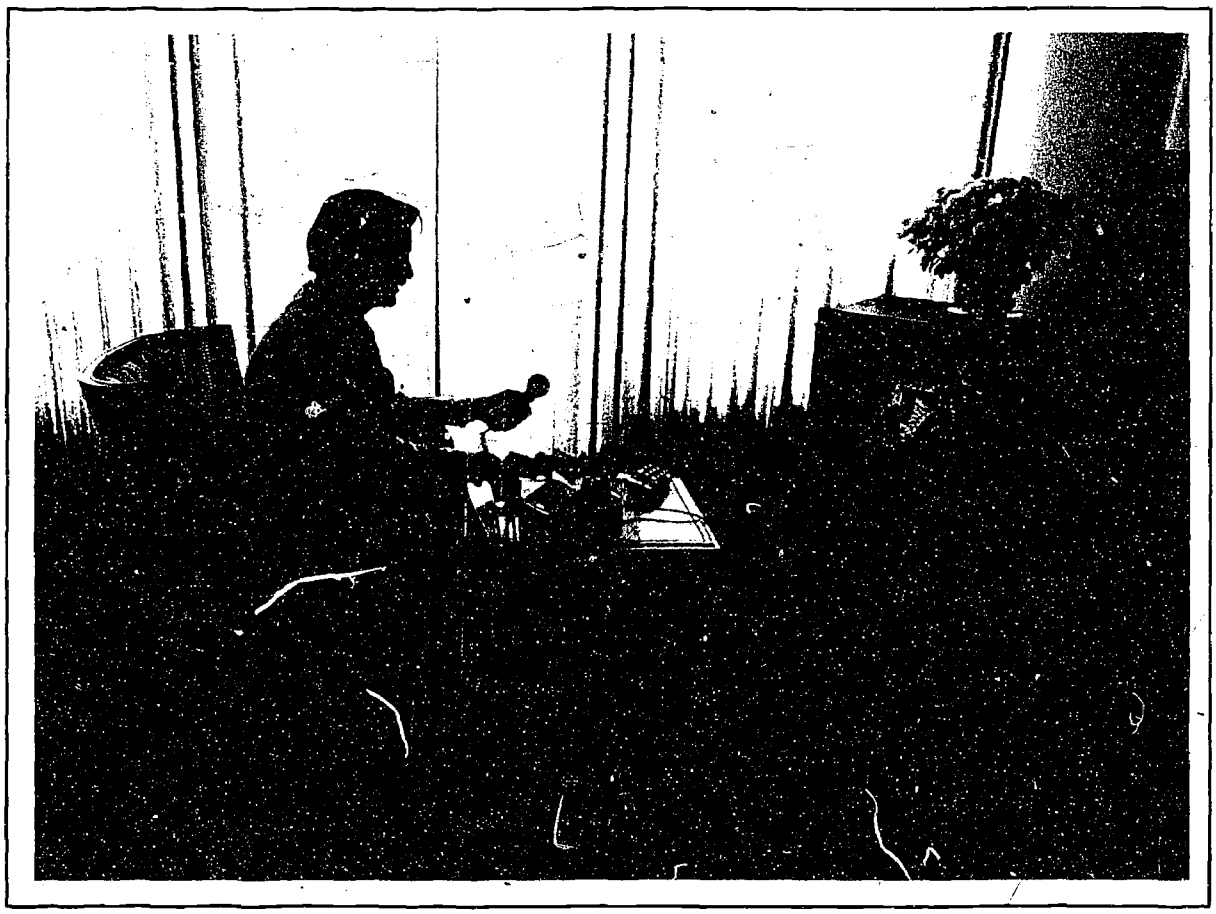
ABSTRACT

This first of a four-volume series of reports summarizes the results of the MITRE Corporation's five years of technical, economic, and operational studies of interactive television. First reviewed are some major accomplishments such as: 1) the development of a new cable television (CATV) system configuration 2) the application for social services delivery of computer operating system software products; 3) the demonstration of interactive television service and of a two-way broadband link; 4) plans for a home/school instructional program; 5) selection of pilot interactive television services; and 6) recommendation for urban interactive television trial sites. Following this, major sections are devoted to discussions of progress in the technology of interactive television, of the economics of operating an interactive cable system, of operational considerations for interactive television, of demonstrations of interactive television, and of plans for the immediate future. (PB)

INTERACTIVE TELEVISION



M72-200 Vol. I
Revision I

MAY 1973

THE MITRE CORPORATION

INTERACTIVE TELEVISION

A NEW USE OF CABLE TO PROVIDE INSTRUCTION, INFORMATION, COMPANIONSHIP AND ENTERTAINMENT, ON DEMAND, IN THE HOME

Welcome to the MITRE Corporation's demonstration of interactive television.

The MITRE Corporation is a not-for-profit, systems analysis and engineering company, located in McLean, Virginia.

A Computer-Assisted Instruction (CAI) program sponsored at MITRE by the National Science Foundation has yielded experimental results which may lead to mass education and instruction for less cost than traditional methods.

To demonstrate this, two community colleges will begin using 128 terminal systems on a development basis during the 1973/74 academic year. The project cost per student contact hour is less than one dollar (only a third of current traditional cost).

MITRE's work with CAI stimulated the concept of delivering computer-controlled information and instruction directly into people's homes via a cable television system. This vital community information system would include the innovations that characterize MITRE's interactive television system, which are:

- the use of standard color TV receivers;
- the provision for audio support of the visual display;
- the large number of terminals, each acting on independent demand and controlled by minicomputers;
- the low cost of terminals;
- the low cost of instruction delivery.

Interactive cable television offers, in your home, indivdualized services on demand. Requests from many points are accepted simultaneously by the minicomputers and detailed information is delivered economically and, if necessary, privately to any cable subscriber. Interactive cable television provides programmable computer capability in the home.

Soon a significant step will be taken. The National Science Foundation is funding a program in which 3,500 homes in Reston, Virginia and three elementary schools of this planned new town just outside Washington, D.C. will be able to experiment with interactive television.

The prototype services will be drawn from these categories:

(1) Instruction—Elementary grade computer-assisted instruction. The Fairfax County (Virginia) Public School administration is working with MITRE to design a system and to evaluate suitable program materials for their specific CAI needs.

(2) Companionship for the Housebound—Imaginative communication services for senior citizens, the infirm, mothers and the urban-isolated, providing information to make the community more vital and help members be more aware of each other. Programs such as "Who's Who in Town," "Who's New in Town," skills, hobbies, etc. will help to stimulated person-to-person and telephone contact, and help to alleviate urban alienation.

(3) Community Ombudsman—Here the computer is used to store information on community, municipal, county, state and national government services. These are, in general, not advertised. In the small communities of previous days there was often an individual, a local political leader, to whom one could turn for advice. The typical urban transient population does not develop such people. Interactive television can screen the problem and guide the user to the correct information resource.

(4) Programming in the Schools and Home - This refers to the subscriber designing the medium. New simple computer languages have made it possible for teachers to learn (in a few short hours) to construct individualized instruction programs for children with special needs. This opens up the most exciting possibility that the community members will program their own subjects: instructions to the babysitter in case of emergency; a "white pages catalogue" of community experience, and whatever citizens find useful.

(5) Entertainment - This extensive area includes interactive games with the computer and with others: games of skill, of memory, and of observation. Also, use of the computer to store "rainy day suggestions," party suggestions, where to go, and what to do.

(6) Community Coherence - Examples of the low participation of the population in forums affecting their community and their lives are numerous. The community will be able to use interactive television as a tool to facilitate identification of common problems and to provide a forum for airing special viewpoints. Solutions may be debated in real time or in a "wall newspaper" mode. Immediate polling of preferences on action to change a situation will much improve the quantity and quality of feedback available to community leaders, and enhance community involvement and participation in the governing process.

(7) Community Soapbox - The limited space in "letters to the editor" in local newspapers and even more limited space on television editorials in today's media provides an inadequate substitute for the relative effect an individual in a small community could have to espouse his views. The complete gamut from politics to poetry can be stored for perusal, on demand, by only those who are interested. The low expense of a single time storage in a computer-data base makes available a communications media that has no adequate substitute in today's society.

(8) Health Care - Interactive television's use to disseminate preventive medical information to the "activated patient" - a patient whose own paramedical skills and understanding of health is upgraded in order that he may become actively responsible for managing his own health care.[1]

Preliminary calculations indicate that a wide range of such services may profitably be offered for approximately $14 per month in addition to the regular one way CATV charge. The initial phase of the Reston trial will be free. As the service offering expands, a modest charge (yet to be determined by NSF) will be introduced.

Control over the data base (the computer's stored information) and who has access to it is probably the single most important problem to be resolved by means of trials in real community surroundings through these experiments.

No one yet knows just what the impact of interactive communications in the home will be, there are substantial claims for the potential of multi service telecommunications: new life patterns for city dwellers are predicted.[2]

Professor Edwin Parker of Stanford University predicts, "An information utility could be made available to every urban home and rural community in the United States by 1985."

Our purpose is to show that this new communications medium is capable of delivering many services of true social significance in addition to commercial and business activities. Eventually we hope such services will help relieve many of the ills of our modern urban life.

[1] This concept has been introduced by Vernon Wilson, H.E.W. Health Services and Mental Health Administration.

[2] *Communications Technology for Urban Development*, A report of the Committee on Telecommunications, National Academy of Engineering. "Multiservice Cable Telecommunications Systems: The Wired City", Department of Communications, Government of Canada.

M72-200

A STUDY OF THE TECHNICAL AND ECONOMIC CONSIDERATIONS ATTENDANT ON THE HOME DELIVERY OF INSTRUCTION AND OTHER SOCIALLY RELATED SERVICES VIA INTERACTIVE CABLE TV

VOLUME I: INTRODUCTION AND INTERIM SUMMARY

KENNETH J. STETTEN

JOHN L. VOLK

MAY 1973

THE MITRE CORPORATION
WASHINGTON OPERATIONS

A C K N O W L E D G M E N T S

This work is supported by National Science Foundation's Grant GJ-32785. The report was written by the authors, but its content reflects the concepts and work of the Computer Systems Department, as well as numerous consultants.

The program is being performed under the direction of Kenneth J. Stetten, Principal Investigator and Head of the Computer Systems Department at The MITRE Corporation in McLean, Virginia.

"Since the computer first appeared in the late 1940's, the information industry has been a certainty. But we do not have it yet. We still do not have the effective means to build an "information system." This is where the work is going on, however. The tools to create information systems may already exist: the communications satellite and other means of transmitting information, microfilm, and the TV tube to display and store it, rapid printers to reduce it to permanent record, and so on. There is no technical reason why someone like Sears Roebuck should not come out tomorrow with an appliance selling for less than a TV set, capable of being plugged in wherever there is electricity, and giving immediate access to all the information needed for schoolwork from first grade through college."

Peter F. Drucker,
THE AGE OF DISCONTINUITY

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F O R E W O R D

This report was written to describe progress by the Computer Systems Department of The MITRE Corporation on a study of the technical, economic, practical, and social considerations attendant on the delivery of instruction and related services via interactive cable television. The work was directed toward uncovering and resolving problems and developing opportunities associated with our plans to test an interactive television system serving several thousand subscribers on a daily basis. This report, Volume I, covers the first nine months of work (Phase I) ending in October, 1972. The grant was succeeded by a seven-month effort (extended Phase I), Initial Implementation, reported on in Volume IV.

At the time of this writing, The MITRE Corporation is actively preparing to implement delivery of services and measuring the community response to 3500 homes and three schools in Reston, Virginia.

Other volumes in preparation for issuance in the near future are:

VOLUME II TECHNOLOGICAL AND ECONOMIC CONSIDERATIONS FOR INTERACTIVE TELEVISION

Alternative Interactive Television Configurations -- Phase II Hardware Detailed Design -- Data Base Management and Retrieval Design -- Economic Evaluation Models

VOLUME III SOCIOLOGICAL AND INSTITUTIONAL CONSIDERATIONS INVOLVED IN THE IMPLEMENTATION OF INTERACTIVE TELEVISION

Predicted Sociological Impacts of Interactive Cable Television -- Selection and Evaluation of Types of Services -- Analysis of Some Selected Social Needs -- Evaluation of Cities for Future Urban Tests

VOLUME IV IMPLEMENTATION PLAN FOR THE MARKET TEST IN RESTON, VIRGINIA

Phase II Technology -- Educational Content -- Health Care Content -- Community Information Content -- Evaluation Plan

1.0 INTRODUCTION

1.1 The Promise of Interactive Television

New forms and imaginative uses of telecommunications can make contributions of fundamental importance to meeting and solving nearly every major problem of urban society and urban life. The Report recently issued by the Committee on Telecommunications of the National Academy of Engineering, whose membership is widely representative of government, industry, and national civic groups, states:

> Our cities have many problems in urgent need of solutions. City governments have a requirement for closer communications with their citizens and readier response to citizen needs. City schools are less than satisfactory in providing quality education to the nation's youth. Medical care is inadequate for the cities' poorer and older citizens. Individualized transportation is clogging the streets and polluting the air. Public transportation is often inefficient and unattractive to its users. Law enforcement agencies have difficulty in coping with a growing crime rate.
>
> The Committee believes that modern communications technology, thoughtfully applied, can help in relieving many of these problems and in upgrading the level of city life. This conviction has been further confirmed as a result of the Committee's in-depth study of city operations, and a continuing exchange of ideas with officials in a cross-section of U. S. cities.[1]

Interest in telecommunications as an increasingly powerful tool for dealing with urban problems is now worldwide. A telecommunications study made by the Canadian Department of Communications says:

> Multi-service telecommunications systems can provide not only means of developing new life patterns for city dwellers, but also solutions to many of the ills of urban

[1] A Report of the Committee on Telecommunications, National Academy of Engineering, Communications Technology for Urban Development, June 1971, page 1.

> living. Through the planned use of such systems, urban dwellers will be able to enjoy ordered, well-defined, and harmonious surroundings. They will have the opportunity of participating in society in a manner never before possible.[2]

In these and other studies, interactive television, brought to cities and communities through cable systems, is a coming communications mode that could have particularly high social value. Urban planners, social scientists, and historians are increasingly concerned that one-way TV communications may be adding to, rather than ameliorating, basic problems of our society. In an article on television in Life magazine, Daniel Boorstin, Director of the National Museum History and Technology of the Smithsonian Institute, calls for a new technology and new uses to overcome TV's limitations:

> ...The great test is whether somehow we can find ways in and through television itself to break down the walls of the new segregation -- the walls which separate us from one another, from the sources of knowledge and power, from the past, from the real world outside.
>
> We must find ways to decentralize and define and separate TV audiences into smaller, more specific interest groups, who have the competence to judge what they see, and then to give the audiences an opportunity to react and communicate their reactions. We must try every institutional and technological device -- from more specialized stations to pay TV, to cable TV, and other devices still unimagined.[3]

A second source of increasing interest in interactive TV stems from its potential for performing functions and delivering services

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[2]Government of Canada, Department of Communications. Multiservice Cable Telecommunications Systems: The Wired City. Final Report of Telecommunications Study 8(d). Ottowa, 1971. Typescript page 15.

[3]"Television, more deeply than we suspect, it has changed all of us," Life, September 10, 1971.

that cannot be provided by one-way communications and that offer great promise for ameliorating problems caused by growing urbanization. These services might enable better access to education, wider and better dissemination of health care, direct access to a wide range of information through computer hook-ups, delivery of specialized visual material to the home when the subscriber wishes to see it, facsimile printing of material in the home, and greater participation of urban population in civic life through polling and direct interaction with political leaders.

Interactive television, built on the existing highly refined television technology, in which American citizens have already invested over 20 billion dollars, has been developed to the point of public demonstration.[4] By coupling home television sets on cable systems to computers, interactive television is ready for studies, experiments, and demonstrations leading to the fulfillment of its potential.

Professors Edwin B. Parker and Donald A. Dunn point out in a recent article in Science[5] the great promise of interactive television, especially when combined with video cassettes, computer information systems, and communications satellites, which they call the total "information utility". They see the greatest single potential for this nationwide information is its capability to reduce the unit cost of education and to increase productivity in the knowledge industry. Not only would the

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[4]The Reston, Virginia Test of The MITRE Corporation's Interactive Television, MTP-352, The MITRE Corporation, 1971.

[5]Parker, Edwin B and Dunn, Donald A., "Information Technology: Its Social Potential," Science 176:1392, June 30, 1972.

capacity of the individual instructor be enhanced, but educational institutions would be aided to meet the important challenges of equality of access to educational opportunity and open enrollment in universities, life-long learning, and the need for periodic (or continuous) retraining accommodated to the individual on a flexible schedule in the home or office, and diversity of curriculum content to meet demands for relevance and variety.

Noting the low cost, large capacity, and local coverage available through cable television, Parker and Dunn point up the greater variety of program content that would become available to satisfy many minority interests and tastes not now served by television. They feel further social potential would be discovered by legislation that guaranteed non-discriminatory access to expression of various political, social, and ethnical viewpoints and to stimulate availability of the media to the economically and culturally deprived. They even see the information utility as an aid to solving the problems of congestion of the cities because it would lead to greater physical decentralization of business and other facilities. They state:

> The social goal of such an information utility would be to provide all persons with equal opportunity of access to all available public information about society, government, opportunities, products, entertainment, knowledge, and educational services. From the subscriber's perspective, such a system would look like a combination of television set, telephone, and typewriter. It would function as a combined library, newspaper, mail-order catalog, post office, classroom, and theater.[6]

[6] The Subscriber Response, Hughes Aircraft Company, 1971; A Program to Implement Communication Services, A. D. Little, Inc., 1970.

The private sector recognizes the potential value of two-way TV for selling products and services, and is developing such uses. But what is the place of services with high social utility, with either low or longer-term commercial applications if the development of interactive TV is supported by venture capital from only the private sector? One cannot be optimistic that the private sector will explore the possibilities of such uses on more than a token basis without firm policy guidance and strong initiatives from government institutions, if we look to commercially broadcast television as a model. We have, therefore, begun studies leading to the development of a broad base of data and information on interactive services and a prototype installation from which more extensive data and information can be compiled on the basis of demonstration and experience.

1.2 The Problem of Interactive Television

Discussions of the future of cable television often present glowing pictures of potential two-way communications services on cable. Extensive lists of potential services have been compiled. Commercial services, such as security alarm monitoring, remote shopping, and computer-to-computer data transmission are often cited as important to the economic success of cable television in cities. It is also recognized that non-commercial services, such as interactive educational television in the home and direct citizen feedback on local political issues, would be of great public benefit. Impressed with these possibilities, the Federal Communications Commission has recently ruled that all new cable

systems installed in the hundred largest U. S. television markets must have a two-way transmission capability.

As is often the case with emerging technologies, the promise of two-way services on cable has, at times, been oversold. Although most proposed new services are technically feasible, many may not be economically feasible. Others can probably best be accommodated on the telephone network or by other means. Some may not be desirable at all. The value to society of, and the commercial demand for various new cable services is unknown at the present time.

As it turns out, the near-future capital investment per subscriber to provide the delivered technology system for providing this vast potential array of services is smaller than that currently invested in the U. S. telephone system (investment is approximately $1000 per telephone, although incremental costs to the system are in the $1200 per telephone range). Thus, a most tempting set of commercial opportunities exists on the horizon. Most people knowledgeable in communication, academia, government, and commerce, see mass utilization of two-way CATV as an eventual certainty.

Because of the present lack of any market tests of these services not only is the investment community reluctant to support expansion in this area, but government planners from municipal to federal, from educational specialists to telecommunication regulators are also reluctant to initiate programs without information on citizen response to this new media. It seems probable that such uses as credit card validation and point-of-sale terminals (leading toward the cashless society)

in the next three years will develop information on the market for commercial services. We believe the same should be done for the non-commercial services, to investigate options such as interactive educational television for the home.

Citing an historical analogy, Stanley Scott of the University of Southern California refers to a speech by Herbert Hoover in 1922 on the future of first generation radio, then scarcely in its infancy. President Hoover stated; "It is inconceivable that we should allow so great an opportunity for public service to be drowned in advertising chatter." "Yet," says Professor Scott, "we proceed to fumble our way toward a system under which advertising and its influence, while not 'drowning' the media, certainly dominated its development, preempted its time, and controlled its programming. This system has seen three generations of electronic communications -- AM, FM, and over-the-air TV -- experience abysmal failures to achieve social benefits that the developing technology could have produced. If government laissez faire continues, we may be assuring that media history repeats itself. The only viable alternative is a deliberate act of public will." Scott calls for: 1) public interest-oriented organizational support, and 2) a strong financial base that does not depend primarily on advertising, unless the forces of advertising are neutralized or otherwise kept under control.

Professors Parker and Dunn are more optimistic:

> Although some consider any services other than entertainment that might be provided by cable television as speculative, most knowledgeable observers expect strong growth to take place in additional services..."

They conclude:

> In order to accomplish these positive social goals, a detailed plan for federal action and participation is needed. Since most of the funds for this utility will come from the private sector, the principal needs for federal action are in the areas of coordination, policy analysis, and assessment, and the funding of pilot projects and demonstrations designed to stimulate the development of new public sector education and information services.[8]

Since it will take so much time before mass test and social feedback occur, The MITRE Corporation has explored the feasibility of a quick-thrust implementation in one or a few communities that can significantly decrease the knowledge gap in this area. We have reason to believe, based on our own efforts in this new technology, the comments of others on our implementation so far, and the proposed implementation of a number of organizations, that it should be possible to determine a community's response to the availability of interactive television. Of major importance is the concept that the set of services will be chosen by the community from an initial offering, and will not just be predetermined by MITRE.

1.3 Overview of MITRE's Program in Interactive Television

Since 1968, MITRE has been actively developing a computer system called TICCIT (Time-shared, Interactive, Computer-Controlled Information Television). Through the coupling of commercial television and advanced computer technology, MITRE has attempted to open new areas

[8] Parker, Edison B. and Dunn, Donald A., "Information Technology: Its Social Potential," Science 176:1392, June 30, 1972.

for cost-effective utilization, with emphasis on computer-assisted instruction.

A milestone was reached in J[illegible], 1971, when the country's first interactive television system was demonstrated in a Reston, Virginia home by MITRE. This system connected standard television receivers in a few homes and schools in Reston to MITRE's computer system via the Reston cable television system. A demonstration of a great variety of potential interactive services has been demonstrated to government and industry leaders (representing the 148 institutions and organizations listed in the Appendix) during the following year.

In December, 1971, NSF awarded a grant to MITRE to study the technical and economic considerations attendant on the home delivery of instruction and other socially related services via interactive cable TV. The emphasis was on the problems associated with the development of an interactive television system serving several thousand subscribers. This study is the first part of a planned three-phase program, shown in Table I, that will lead to the installation and evaluation of an interactive television system in a yet-to-be selected urban community.

1.4 Program Progress

This, the first of a four-volume series of reports, summarizes the results of MITRE's five years of technical, economic, and operational studies of interactive television. Subsequent volumes will emphasize special areas.

TABLE I

PROGRAM OUTLINE

Phase I - Design and Evaluation Study

- Perform subsystems and component design of hardware and software.
- Develop economic evaluations of system capabilities and configurations.
- Develop criteria, rationale, and make preliminary recommendations for initial service offerings.
- Develop criteria for and evaluate urban center test site candidate selections.
- Conduct complementary theoretical and practical analyses of time-shared interactive service delivery.
- Prepare a plan for Phase II.

Phase II - System Development

- Home-test hardware for reliability, function, and human engineering considerations.
- Home-test software for reliability, function, and human engineering considerations.
- Develop social service content.
- Test in Reston to determine subscriber response.
- Select urban test sites.
- Develop installation plans for urban test sites.

Phase III - Implementation and Measurement

- Install system in test community
- Modify services in response to community feedback.

TABLE I (Continued)

PROGRAM OUTLINE

- Operate and Maintain the system; perform demonstration and tests.
- Measure subscriber response.
- Evaluate results of demonstrations and tests.

The latest major technical accomplishments of the program are:

- Development of a new, economically advantageous CATV distribution system configuration, especially suited for interactive television and compatible with cable operators' constraints in large urban centers.
- Application for social-services delivery of computer operating system software products developed under MITRE's CAI project.
- Demonstration of interactive TV service concepts delivered over a CATV system controlled by a stand-alone minicomputer system.
- Demonstration of a two-way, broadbank link on the Reston CATV system.
- Plans for development of a home/school instructional program plan in cooperation with three Fairfax County, Virginia elementary schools.
- Selection of pilot, interactive television services that have a broad appeal to all economic, age, and educational levels.
- Recommendation for urban center interactive television trial sites.

Another major accomplishment has been the development of an economic analysis model, capable of handling advanced interactive television CATV systems. Based on a twenty-year project, cash flow may be traced for various penetration rates, monthly charges, and implementation strategies. This new model, which has evolved from one developed for an urban cable systems study recently completed by MITRE for the

John and Mary R. Markle Foundation, has been used to analyze one Washington, D. C. service area defined in this earlier study, using the actual demographic, business, and system parameters as input data. The results indicate that interactive television in the selected area would be economically viable at charges of $14.00 per subscriber per month. Naturally, this value is sensitive to many parameters. Section 2.3 and Volume II treat this complex area in detail.

In the operation area, MITRE focused on the selection of interactive television services, the management of service production, and the selection of candidate test sites for an eventual trial of interactive television. To gather suggestions and advice, MITRE convened two advisory panels. Educational, social, and communications specialists served on the first panel; practitioners in print and television media on the second.[9] All of the panelists expressed enthusiasm for the potential of interactive television. They affirmed that TICCIT must be able to successfully vie for viewer's time before attention can be concentrated on the social impacts. Each panelist provided examples of communications problems within his special field that would be alleviated by the flexibility and responsiveness of interactive television.

The results of the study convinced us that meaningful experiments with interactive television can be made today. The technology is available (a large set of interactive services can be offered

[9] Tables III and IV list the panelists.

without the addition of any significant new electronic equipment in the home), the cost is reasonable, and the operational problems of service selection, production, and test-site selection appear manageable.

2.0 PROGRESS IN THE TECHNOLOGY OF INTERACTIVE TELEVISION

We believe the most important technical achievement of this program has been the conceptual development of a CATV system configuration especially engineered to be economical for delivery of interactive television services. This configuration permits immediate testing of interactive services with a large-sample population. A major advance has also been made in software products, developed under a related CAI system development project at MITRE, utilizing television-delivered instruction. Many of the most complex software package programs (for instance, the real-time operating system) will be used in both applications.

Other accomplishments of the program are: (1) the country's most sophisticated interactive TV demonstration, (2) a study of projected subscriber fee and commercial operational financial implications of this technology, and (3) a two-way CATV installation in Reston, now being installed and tested through the cooperation of the Reston Transmission Company and TeleVision Communications, Incorporated (respectively, operator and owner of the test-site cable system).

2.1 New CATV Configuration to Support Interactive Television

A broad system's approach to interactive television has not been taken by any of the commercial developers of interactive television hardware. For the most part, only bits and pieces have been demonstrated in two prototype two-way systems. These have been interactive only in the sense that subscribers can respond. None have offered individual services. No company has yet developed a clear plan that leads the system

operator from a conventional one-way system through various levels of interaction, to a full, TICCIT-like system in an evolutionary or cost-effective manner.[10] For this reason, we have developed an evolutionary implementation plan that maximizes the use of available channel space and time-shares the expensive components. Evaluations of configurations and their costs are continuing, and will be included in Volume II. The following is a summary.

For more than a year, MITRE has been experimenting with and publicly demonstrating an interactive television system in Reston, Virginia, in conjunction with the Reston Transmission Company. A major impediment to the operational implementation of this system has been the cost of the refresh memory needed in each home utilizing interactive television. The refresh memory and its associated electronics cost more than $1000 when bought in moderate quantities. In Reston, a video-tape recorder was used as a refresh memory (in its stop-frame mode), providing the home-owner with not only a refresh memory, but also a video recorder/player. But even with its multiple uses, the refresh memory costs a disproportionate amount, relative to the cable television system.

To overcome this problem, we are taking a new approach. We assume that the average household will use interactive television services that require a computer-generated display (and, hence, a refresh memory) about thirty minutes each day. Assuming a ten-hour day, this means that one refresh memory could serve up to twenty households with

[10] Such as is described in "Urban Cable Systems," MITRE Report M72-57.

interactive television services. This is equivalent to a 5% load factor. Some peaking will occur; until usage statistics are gathered, assumptions have to be made on how parameters such as system availability and pricing strategy affect demand. In practice, this will be predominantly a function of the type of service and the user, hence experimentation is essential to the validation of this approach. We have used queueing theory to evaluate this system configuration; with the present necessary assumptions, we are satisfied that delays will not be unreasonable. Volume II details this analysis. On a long-term basis, we foresee the following scenario: As the market and services for interactive television develop, and the cost of refreshers decreases (to, say, $200-300), heavy users of the system may lease their own refresher, allowing them to bypass queues at peak hours on dedicated channels by using a time-shared addressed, multiplexed channel. For example, a school making continuous use of its television terminals would best be served by such a multiplexed channel, feeding refresh memories associated with each display. It is clear that the refresh memory is a key element in the distribution system; as a contribution to the progress in this field, MITRE has developed a solid-state frame-grabber. It is not clear, in any general sense, whether a mix of dedicated and multiplexed channels (that is with refresh memories at a central location at subscribers' TV receivers) is a desirable operating configuration, or whether a system must, for practical reasons, be either one or the other. MITRE is analyzing alternate systems in an attempt to discover how combinations of subscriber density, service load, and refresh costs affect this choice.

The advantage of sharing refresh memories is obvious -- the cost per refresh can be spread over many users. The central location of the refresh memories creates a need for a communication channel between the shared-refresh memories and the home-television receivers. As shown in Figure 1, the cable system is divided into cells of about 200 subscribers. Each cell is connected, with its own trunk cable, to a hub, and each hub services about ten trunk lines (i.e., approximately 2000 subscribers per hub). The hub, in turn, is connected to a common-program source, the headend. About ten channels on the cable system are dedicated to interactive television. Broadcast television is transmitted through the system from the headend to the hub to the trunk, and, finally, into the homes in each cell. The interactive television channels flow only from refresh memories in each hub to the homes in each hub's cells via the individual trunk lines. Each trunk line in this example has ten refresh memories associated with it, one for each interactive channel. The users in each cell, therefore, have access to ten refresh memories by tuning to the ten interactive television channels. Located in each hub is equipment to place the broadcast television signals on each of its ten trunks, along with the outputs of the 100 refresh memories. The hub also contains either the computer to provide interactive television services, or equipment to allow a remote computer to serve it. Communication from the home keyboard (and other devices, such as meter readers, burglar alarms, etc.) to the hub is accomplished with a separate, relatively narrow-band

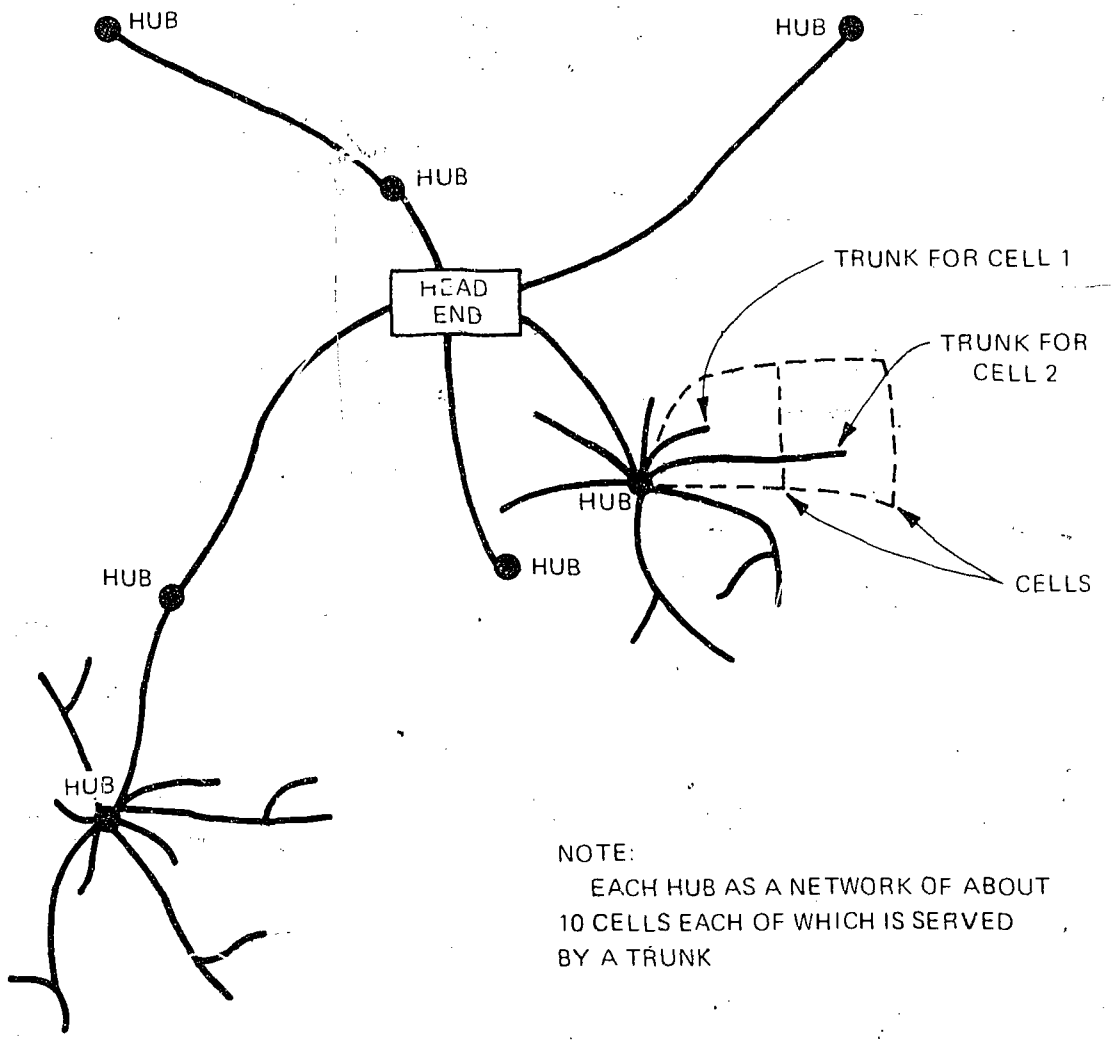

FIGURE 1
HUB CATV SYSTEM WITH TRUNKING TO INDIVIDUAL CELLS

digital communication signal on the same trunk that carries TV signals to the home.

Thus the MITRE hub-type system combines switching characteristics, (which have some similarities to the functions carried out by a Discade or Rediffusion hub), and the traditional distribution and signal origination role exercised by a conventional, one-way system hub. The MITRE hub concept serves fewer subscribers than conventional hubs, so as to increase channel capacity per subscriber, and to improve point-to-point CCTV capability, audio distribution, and store-and-forward communication potential.

The MITRE hub-type system has an added attraction, it reduces the spurious signal pickup problems that have plagued early two-way experiments and places less of a demand on cable amplifiers. These advantages (expanded on in Volume II) and the minimization of special hardware in the home have contributed to the encouragement we have received from industry leaders, briefed on the new approach.

All viewers located within a cell are able to view material intended for anyone within that cell. If the material requires privacy, it is necessary to scramble the video at the headend and descramble at the home, with a code known only to the intended viewer's terminal. Fortunately, equipment to perform this function is being independently developed by a number of firms to provide "pay TV" services. It is likely that this equipment, which has an expected cost of $25-50 per terminal, will be widely implemented to allow "pay TV," regardless of

TICCIT implementation, and can perform the additional service of providing TICCIT privacy at little or no additional cost.

Three types of home keyboards will be used in the interactive system; a simple, twelve-button keyboard (similar to the "Touchtone" pad) will be the standard input device; a full, typewriter-like keyboard will also be available to those users who wish to enter textual material or to take a major CAI course. In both cases, a CATV cable will carry the keyboard signal to the computer. A time-slicing digital communications technique will be used to provide each user with the capability of continuously entering data at a rate equivalent to 100 typed words per minute. For the immediate future, however, we recognize that most existing CATV systems do not have two-way capability (this will gradually change in the next five years because of new FCC rules -- see Section 3.3), and that, initially most users will enter the interactive program only infrequently. For this reason, we will provide the interactive capability using existing home Touchtone telephones as entry devices. While there are many reasons why the telephone is far from ideal for the long range application, we feel it is a good interim device for the less expensive approaches MITRE is developing.

2.2 Interactive TV Test-Bed

Through the generous cooperation of the Reston Transmission Company (RTC), MITRE has been using the Reston CATV system as a test bed for its interactive TV experiments since May, 1971. The system is of high technical quality, but it lacks an operational two-way capability.

Because of the numerous technical problems associated with two-way cable communications, MITRE has felt that it should conduct tests and experiments on a two-way system. To meet this need, a portion (15,000 feet of cable) of the Reston Cable system has been retrofitted for two-way operation by the Jerrold Corporation, under contract to the cable system owners. The funds for this hardware expansion (approximately $25000) were provided by TeleVision Communications, Incorporated, a division of Warner Communications, which controls Reston Transmission Company's cable television system. With excellent cooperation on the part of the cable system operator, two-way video digital and audio experiments were conducted ahead of schedule.

During the study phase, the Reston TICCIT demonstration test-bed system has been maintained and shown to many government and industry people. The computer control was successfully changed over from the original IBM 360/Honeywell 516 machines to a stand-alone Data General minicomputer. In addition, an all-solid state digital refresh device replaced the video-tape player as the frame grabber, and the system output to the cable was converted to a NTSC color signal, so that home subscribers may now view interactive television in full color. The range of service presentation techniques has been expanded to include graphics, a choice of font, slides, and the selection of video tape materials.

Any of the 3,500 subscribers to the Reston Transmission Company CATV service can now (one at a time), call up the existing MITRE data

base of information and entertainment for display on his home receiver. using his Touchtone telephone as the feedback mechanism. During the coming seven months, the system capability will be expanded so that hundreds of families will have scheduled, real services available on a time-share basis, in which approximately 20 lines are available simultaneously.

3.0 ECONOMICS OF OPERATING AN INTERACTIVE CABLE TV SYSTEM

MITRE has developed, under this grant, an economic model of a CATV system.[11] It is especially designed to test the economic viability of alternative cable systems, both in terms of configuration and financial operation. The concepts employed in the computer-based Interactive Cable Economic Evaluation Model (ICEEM) are the standard ones used in the field of engineering economics and capital budgeting.

On the financial and marketing level, the ultimate viability of TICCIT rests upon market acceptance of TICCIT services, delivered at costs that justify system implementation. No matter how sophisticated the feasibility study, the question of market success will ultimately be settled through the actual offering and marketing of services. With this in mind, considerable effort has been invested in devising system configurations that minimize the commitment of investment, prior to the demonstration of consumer acceptance.

For persuasive technical and economic reasons, TICCIT is best implemented through cable systems. The genesis of cable television has been its operation as a community antenna system for carriage of distant TV signals. If cable is to serve as the transmission medium for TICCIT and other interactive services, then TICCIT must be evaluated within the economic and financial context of the existing cable

[11] This model has benefited from prior MITRE work supported by the Markle Foundation, reported in "Urban Cable Systems", M72-57, W. F. Mason et. al, of The MITRE Corporation, dated 1972.

television industry, the services it currently provides, and its prospects for the future.

The economic and financial studies, involving a thorough consideration of cost/service/system combinations in conjunction with trade-off studies and sensitivity analyses, have required a major computational effort. Although some computer programs that deal with cable television's economic viability are available, none were found capable of dealing with a hierarchy of service levels and alternate system strategies, including interactive computer-based services.

ICEEM can directly answer the question "how much must be charged for interactive cable services in order to achieve some given rate of return on capital invested over the life of the project?" An example of the ICEEM applied to a two-way system is discussed later in this section. An important area of study using the ICEEM has been the first cost of an interactive cable TV system. Regular one-way CATV systems require high initial capital investment. Expansion into two-way and interactive services is phased to minimize front-end financing. This is reported in detail in Volume II.

3.1 Introduction to the Financial Analysis

ICEEM is a capital budgeting program based upon the discounting of projected cash flows over the expected life of the proposed undertaking. Discounting is future oriented, taking into account the time value of money. The principal outputs are projections of cash flow, profitability, and required revenue. These three important parameters are briefly discussed below.

Cash flow is the flow of cash payments at the moment they take place. Cash flow for the total investment includes capital investments, operating costs, and revenues -- all at the point in time they occur. Cash flow for equity purposes is total investment cash flow, adjusted for cash inflows and loan repayment (both interest and principal) due to debt financing.

Profitability is measured by the rate of return on total invested capital (project rate of return), and the rate of return on common equity. Appearing under many different guises, rate of return is the fundamental measure used in financial analysis. Rate of return is the rate of discount which brings the present worth (capitalized value) of total discounted costs into equality with the present worth of total discounted revenues; both costs and revenues being on a cash-flow basis.

If the rate of return on total invested capital is greater than the cost of debt, then a proposed investment passes the preliminary screen for profitability. At the second level, given the cost of debt and extent of financial leverage, if the rate of return on equity for a given project is at least as great as the rate available on alternative investments in the same risk class (the required rate of return on equity), then the project is considered economically feasible.

The cost of debt, and the required rate of return on equity, weighted by their respective percent contributions, is called the cost of capital.

If the project rate of return exceeds the cost of debt, then increasing financing leverage will increase the rate of return on equity. However, the reverse is also true, increasing leverage can increase the cost of debt and risk to the equity holders.

Discussions with financial representatives of the cable television industry have indicated a target before tax rate of return on total invested capital in the vicinity of 12%. Naturally, the exact desired rate depends upon the anticipated risk of the particular proposed project. Seen in terms of the cost of capital, there are numerous combinations of financial leverage, cost of debt, and rate of return on equity that would produce the same figure. For example:

% Debt Contribution	X	Cost of Debt	+	% Equity Contribution	X	Rate of Return on Equity	=	Cost of Capital
1. .8	X	8%	+	.20	X	30.0%	=	12.4%
2. .65	X	8%	+	.35	X	20.6%	=	12.4%
3. .60	X	8.5%	+	.40	X	18.3%	=	12.4%

Empirical evidence, combined with results of financial stimulations, indicates that, as a result of accelerated depreciation and the investment tax credit, the nominal 48% tax rate on corporate income produces an effective tax rate of about 33%. The before-tax rates of return on equity used in the previous example of 30%, 20.6%, and 18.3%, would become after-tax rates of return on equity of 20%, 13.7%, and 12.2%, respectively. The combination of financial factors listed above reflects actual cable industry experience. (The ICEEM program also calculates an equity rate of return based on borrowing for capital construction only. Since initial operating losses are financed wholly by equity,

this produces an effective leverage of only 64% debt financing, rather than the 80% shown above. The lower figure would be common to the financially weaker owners of cable systems; the top MSO's are capable of achieving the higher leverage with an 8% average cost of debt.) Inflation is taken into account through adjusting the cost of capital. Instead of adjusting costs and revenues for the compounded effect of inflation, the rate of inflation is removed for the cost of capital. For example, the 12.4% rate of return alluded to above, adjusted for 3% inflation, becomes a 9.1% "real" cost of capital.

Required revenue is especially useful where little is known about market prospects. A cable investment can be approached from two viewpoints:

1. Given anticipated costs, charges, market penetration, financial leverage, and cost of debt, what rates of return can be achieved?
2. Given cost of capital, equipment, and operating costs, and expected market penetration, what revenues must accure from each service?

We have called the second method the required revenue approach. ICEEM is unique in its capability to calculate rates of return, given a change structure, and simultaneously to report the required revenue for a given cost of capital (to be able to repay debt and retain sufficient profit to achieve the required rate of return on equity).

3.2 The ICEEM: A Capsule Description

In addition to providing projections of rates of return and required revenue, the computer model calculates financial results for the first six years of the 20-year assumed project life. (Except for inflation, and the automatic provision for replacement investment, years 6-20 are assumed to have identical market penetration and financial results.) Figures reported include revenues, expenses, loan repayment, net income and cash flow (net income plus depreciation and loan repayment). Corporate income taxes are taken into account through adjustment of the required rate of return on equity.

Operating costs and capital recovery (interest plus depreciation) are itemized and totaled. Costs are printed out on an equipment-unit basis. Separate market penetration profiles are available for two classes of services -- one way and interactive television. Cost and revenue categories are itemized. This detailed reporting facilitates a full tracing of cost and revenue origins -- an essential ingredient to engineering economic analyses, and to the pricing of services on a marginal and fully allocated cost basis.

3.3 An Example of Use of the ICEEM: Principle Assumptions

Special consideration has been given in designing the urban TICCIT system, minimizing the hardware investment required before actual market penetration is known. Through cross-wiring, only one-sixth of the expected ultimate investment in computer and other electronics for the chosen example system (see Table II) needs to be undertaken

TABLE II
EXAMPLE SYSTEM DATA

A. NUMBER OF HOUSEHOLDS PASSED BY CABLE 26,680

B. PENETRATION (AVERAGE) PERCENTAGE:

YEAR	1	2	3	4	5	6-20	AVERAGE
HIGH							
ONE-WAY	12	32	47	50	58	76	61.23
TWO-WAY	7.5	20	30	37.5	42.5	47.5	38.27
LOW							
ONE-WAY	6	16	24	30	34	38	30.62
TWO-WAY	3.75	10	15	18.75	21.24	23.75	19.14

C. BASIC SYSTEM - NUMBER OF CABLE MILES - 76

D. TICCIT SYSTEM - NUMBER OF CABLE MILES - 107.5

in the initial stages. The moderate increases in wiring costs are completely offset by the interest savings and reduction in investment risk.

As previously discussed, if the cost of capital has been set at 12.4%, after-tax rates of return on equity in the range of 12-20% may be expected (depending upon the particular financial circumstances, expecially the strength of the system owner). An inflation rate of 3% per annum is assumed to apply equally to costs and revenues.

The duration of the franchise and the economic life of cable distribution plants both have been set at 20 years.[12] All electronic equipment -- home terminals, converters, and electronic equipment in the local distribution center or subheadend and headend -- have been assigned an economic life of five years. The actual, physical life should be much longer; the five-year life is assigned principally because of expected obsolescence resulting from cost reduction and improved performance. This assumption is conservative since replacement equipment would have to be both cheaper and better, to justify the short economic life. This has not taken into account projecting replacement costs.

The unscrambler provides a first level of security, achieved through selective gating of access. It is recognized that higher levels of security, involving actual scrambling, would be necessary

[12] Previous financial analyses of cable systems have assumed system sale after 5-10 years. Assumptions about the sale price significantly effected the over-all results -- the tail wagged the dog.

if sensitive material were to be transmitted. The TICCIT system, analyzed, uses digital central refresh with the hub configuration. At maximum assumed market TICCIT penetration (50% houses passed by the cable), the maximum-assumed possible usage rate is 5% of subscribers at any one time. Queueing considerations may reduce this figure by 10-40%, depending on acceptable wait times and probability of getting a busy signal.

The analysis is conducted on an incremental basis. The base one-way system has twin cable with set-top converters. Eventually, the system has a two-way capability; however, the second cable is quiescent (amplifiers not installed).

Table III shows a breakdown of system componentscosts that are based on our estimates for limited quantity production within the near term.

3.4 Results of Example Application of the ICEEM

In the analysis conducted for a hypothetical system, a section of Washington, D. C., with a total of 26,680 households was passed by the cable. Separate penetration profiles are projected for one- and two-way services, and sensitivity analyses are conducted for high and low penetration profiles. System data are shown in Table II.

Results are in terms of required monthly revenue. This is the revenue required to yield a 12.4% rate of return on total invested capital over the 20-year life of the system. Values are given for the high- and low-penetration assumptions.

TABLE III
LISTING OF COMPONENTS AND CAPITAL COSTS
OF DIGITAL CENTRAL REFRESH SYSTEM

AT HUB:

	DOLLARS	
COMMUNICATION PROCESSOR	21,000	
MAIN PROCESSOR	26,000	
PERIPHERALS	95,000	
KEYBOARD DATA MOD/DEMOD	5,000	
REFRESH CONTROL ELECTRONICS	10,000	
CHARACTER GENERATOR	7,000	
CHARACTER SWITCHER	3,000	
DIGITAL MEMORY	72,000	(o.62 x 116,000)
NTSC ENCODER	116,000	(1.0 x 116,000)
VIDEO MODULATOR	58,000	(0.5 x 116,000)
SIGNAL SCRAMBLER	11,600	(0.1 x 116,000)
COMBINER/SPLITTER	6,000	(0.5 x 12,000)
TOTAL:	$430,600.00	

TERMINALS:

HOUSE DROP	40.
CONVERTER	27
UNSCRAMBLER	25
DATA MODEM	200
ENCODER/DECODER, KEYBOARD	292
HUB COST PER SUBSCRIBER	203
TOTAL:	$495.00

For the base case, one-way services only, required monthly revenue is \$5.78/\$9.33[13] for high-and low-penetration, respectively (see Table II). Halving the penetration rate increases the required revenue per month by 61%, indicating strong sensitivity to penetration. The required monthly revenue per subscriber assumes an installation fee of \$5.00. Revenues from pay television, second outlets, advertising, and channel lease of the 60-channel system would result in required monthly charges for basic services somewhat lower than the gross revenue requirements.

Required monthly revenue for the TICCIT system alone, on an incremental basis, is \$13.73/\$14.90[13] for high and low-TICCIT penetration, respectively. The average high-TICCIT penetration is 38%, low is 19%. Phased TICCIT is rather insensitive to penetration; a halving of penetration results in only an 8.5% increase in the revenue requirement per subscriber. Combined monthly charge for TICCIT and basic services is \$19.51/\$24.23. This is within the range of the average monthly telephone bill.

3.5 Analysis of Front-End Investment and Cash-Flow Calculations, for Example

The basic one-way system would require a front-end investment of \$1.53 million, and an additional investment of \$67 per added subscriber. The combination one-way and TICCIT system requires a fixed

[13] Also, see Table IV, Section 8.0 for run at high penetration. Results are shown in terms of required annual revenue. Some figures in the test are not derived from the sample output (Table IV), but from other computer runs.

investment of $2.38 million: $1.53 million for the basis system, plus $0.42 million for the additional cable and equipment associated with the hub configuration, and $0.43 million (see Table III) for the hub itself. The additional investment for the combination one-way and TICCIT system is $202 million.

As far as hardware costs are concerned, TICCIT requires a 56% increase in front-end, fixed investment, and a six-fold increase in incremental investment cost. However, at least at the hardware level, financial risk is not great, since even a minimal market penetration for TICCIT, at the indicated charge level, would provide the 12.4% overall rate of return on the TICCIT portion of invested capital.

The major source of risk is the investment in computer software and courseware that would be required to make TICCIT an attractive service. The first large-scale interactive system would have limited program material to draw upon, and would have to bear substantial costs of software and courseware development. This would be recouped, by sale or lease to subsequent systems in other cities, providing the initial experiment proved successful.

In addition to providing information retrieval and computer-aided instruction, TICCIT is capable of point-to-point message forwarding (useful in electronic banking), and message and telegraph services. TICCIT's polling capability is an important feature in the feasibility of pay television because it permits automatic billing and sampling of program popularity in general. The scrambler used for TICCIT could also serve for pay television.

Table IV is a sample print-out from the ICEEM program, which shows the results of the run that determined the required monthly revenue for combined TICCIT and one-way services, under the assumption of high penetration.

As indicated, a positive cash flow is projected by the second year. This is predicated upon rapid completion of the system construction. Under the financing plan shown, a profit position is achieved by the fourth year. If the project were put on a lease-back arrangement, profitability would be achieved by the fifth year. Using 80% debt financing at an 8% cost of debt, a major MSO could achieve a 20% after-tax rate of return on equity. Due to reduced financial leverage, smaller cable system owners would achieve the equity rate of return listed in Table IV of Section 11.0 as 17.03%. This translates into 13.69% when adjusted for inflation and corporate income tax.

TABLE IV

'THE MITRE INTERACTIVE CABLE ECONOMIC EVALUATION MODEL
A FINANCIAL CAPITAL BUDGETING PLANNING PROGRAM

PHASED DIGITAL CENTRAL REFRESH HIGH PENETRATION

1-5. EQUIPMENT COSTS ON A PER UNIT ANNUAL BASIS

	BASIC EQUIP	HOME TERMINAL	LOC DIST CTR	SUB-HEADEND	HEADEND
FIRST COST	67.00	428.00	0.0	365000.00	96111.00
EXP ECON LIFE	5.00	5.00	0.0	5.00	5.00
AMORTIZATION	17.28	110.40	0.0	95578.13	25167.44
MAINT-LABOR	4.80	11.28	0.0	14400.00	1600.00
MAINT-MATERIALS	2.69	19.63	0.0	7300.00	1900.00
VEHICLE-OPER&AMOR	0.75	0.75	0.0	36000.00	0.0
FACILITY RENT&MAIN	0.0	3.13	0.0	13150.00	2778.00
ON-SITE PERS	0.0	5.40	0.0	81600.00	8000.00
YEARLY TOTAL COST	25.52	150.59	0.0	248028.13	39445.44

6. TRUNK AND FEEDER LINES

TRUNK LINES

ABOVE GROUND CONSTRUCTION	11000.00	$/MILE X	32.45	MILES =	$	356993.94
UNDER GROUND CONSTRUCTION	18000.00	$/MILE X	7.00	MILES =	$	126000.00
DUCT CONSTRUCTION	25000.00	$/MILE X	1.40	MILES =	$	34999.99
TOTAL CONSTRUCTION					$	517993.88
AMORTIZED CONSTRUCTION					$	58126.40

FEEDER SYSTEM

ABOVE GROUND CONSTRUCTION	11000.00	$/MILE X	54.00	MILES =	$	594000.00
UNDER GROUND CONSTRUCTION	18000.00	$/MILE X	14.00	MILES =	$	252000.00
DUCT CONSTRUCTION	25000.00	$/MILE X	2.80	MILES =	$	69999.94
TOTAL CONSTRUCTION					$	915999.94
AMORTIZED CONSTRUCTION					$	102788.44

TRUNK LINES

POLE RENTAL	170.00	$/MILE X	32.45	MILES =	$	5517.18
DUCT RENTAL	3250.00	$/MILE X	7.00	MILES =	$	22750.00
LINE MAINT LABOR	280.00	$/MILE X	39.45	MILES =	$	11047.12
LINE MAINT MATERIALS	60.00	$/MILE X	39.45	MILES =	$	2367.24
POWER	20.00	$/MILE X	39.45	MILES =	$	789.08
TOTAL VARIABLE COST					$	42470.61

FEEDER SYSTEM

POLE RENTAL	170.00	$/MILE X	54.00	MILES =	$	9180.00
DUCT RENTAL	3250.00	$/MILE X	14.00	MILES =	$	45500.00
LINE MAINT LABOR	280.00	$/MILE X	68.00	MILES =	$	19040.00
LINE MAINT MATERIALS	60.00	$/MILE X	68.00	MILES =	$	4080.00
POWER	20.00	$/MILE X	68.00	MILES =	$	1360.00
TOTAL VARIABLE COST					$	79160.00

7. OVERHEAD SYSTEMS COSTS

FIRST COST	$ 5000.	
EXPECTED ECON LIFE	7.	YEARS
AMORTIZATION	$ 997.66	
FCC FEE	$ 0.20	PER BASIC SUBSCRIBER
DUES TO TRADE ORG.	$ 0.36	PER BASIC SUBSCRIBER
TRAVEL&ENTERTAINMNT	$ 0.05	PER BASIC SUBSCRIBER
OFFICE SUPPLIES	$ 0.60	PER BASIC SUBSCRIBER
LEASE ON ADMIN BG	$ 0.0	
GEN MAINT&UTILITIES	$ 1.00	PER BASIC SUBSCRIBER
PAYROLL	$ 135500.00	
COPYRIGHT	0.0	PERCENT OF BASIC REVENUES
BAD DEBTS	0.0	PERCENT OF REVENUES
INSURANCE	1.00	PERCENT
PROPERTY TAX	0.0	PERCENT
FRANCHISE TAX	0.0	PERCENT OF REVENUES
SELLING & ADVER	$ 1.00	BASE RATE
MICRO-WAVE RENTAL	$ 10000.00	
OPERATING CASH	$ 1.00	PERCENT OF TOTAL COSTS
PROF SERVICES	$ 0.10	PER BASIC SUBSCRIBER
PROGRAMMING PERS	$ 72400.00	
PROGR OPER EXPENSES	$ 21980.00	
PAY TV MATERIALS	$ 0.0	PER BASIC SUBSCRIBER
SYSTEM SOFTWARE	$ 2700.00	
SYSTEM COURSEWARE	$ 0.0	
PRE-OPENING EXP	$ 46670.00	

YEAR		1	2	3	4	5	6-20
AMOR. OFFICE EQUIP	$	998.	998.	998.	998.	998.	998.
FCC FEE	$	960.	2561.	3842.	4802.	5443.	6083.
DUES TO TRADE ORG.	$	1153.	3074.	4610.	5763.	6531.	7300.
TRAVEL&ENTERTAIN.	$	500.	500.	640.	800.	907.	1014.
OFFICE SUPPLIES	$	1921.	5123.	7684.	9605.	10885.	12166.
LEASE ON ADMIN BG	$	0.	0.	0.	0.	0.	0.
GEN MAINT & UTIL	$	3202.	8538.	12806.	16008.	18142.	20277.
PAYROLL	$	135500.	135500.	135500.	135500.	135500.	135500.
COPYRIGHT	$	0.	0.	0.	0.	0.	0.
BAD DEBTS	$	0.	0.	0.	0.	0.	0.
INSURANCE	$	19001.	19001.	19001.	19001.	19001.	19001.
PROPERTY TAX	$	0.	0.	0.	0.	0.	0.
FRANCHISE TAX	$	0.	0.	0.	0.	0.	0.
SELLING & ADVER	$	6403.	8538.	12806.	8538.	10672.	12806.
MICRO-WAVE RENTAL	$	10000.	10000.	10000.	10000.	10000.	10000.
OPER CASH INTRST	$	1532.	2342.	2993.	3472.	3798.	4123.
PROF SERVICES	$	500.	854.	1281.	1601.	1814.	2028.
AMORTIZED PRE-OPEN.	$	5159.	5159.	5159.	5159.	5159.	5159.
PROGRAMMING PERS	$	72400.	72400.	72400.	72400.	72400.	72400.
PROGR OPER EXPENSES	$	21980.	21980.	21980.	21980.	21980.	21980.
PAY TV MATERIALS	$	0.	0.	0.	0.	0.	0.
SYSTEM SOFTWARE	$	2700.	2700.	2700.	2700.	2700.	2700.
SYSTEM COURSEWARE	$	0.	0.	0.	0.	0.	0.
TOTAL	$	283508.	299265.	314400.	318326.	325930.	333534.

8. PENETRATION AND SYSTEM ASSUMPTIONS

YEAR	1	2	3	4	5	6-20	WEIGHTED AVERAGE
NO OF HOUSEHOLDS PASSED BY CABLE	26680.00	26680.00	26680.00	26680.00	26680.00	26680.00	25328.79
% BASIC PENETRATION	24.00	40.00	56.00	64.00	72.00	80.00	61.23
% TICCIT PENETRATION	15.00	25.00	35.00	40.00	45.00	50.00	38.27
BASIC SUBSCRIBERS BY END-YR	6403.20	10672.00	14940.80	17075.20	19209.60	21344.00	16337.07
TICCIT SUBSCRIBERS BY END-YR	4002.00	6670.00	9338.00	10672.00	12006.00	13340.00	10210.64

SYSTEM ASSUMPTIONS

NO. OF SUBHEADENDS 1
NO. OF LOCAL DISTR CNTRS 6

CONSTRUCTION STARTED 2.0 MONTHS BEFORE REVENUE FLOW

CHARGES AND REVENUE PER SUBSCRIBER

CONNECTION FEE	$	5.00	PER BASIC CONNECTION
BASIC FEE-ONE WAY SERVICE	$	69.34	PER SUBSCRIBER/YR
TICCIT FEE-INTERACTIVE SERVICE	$	164.79	PER SUBSCRIBER/YR
COMMERCIAL INTERACTIVE SERVICE	$	0.0	PER RESIDENT/YR
PAY TELEVISION	$	0.0	PER BASIC SUBSCRIBER/YR
ADVERTISING-LOCAL ORIGINATION	$	0.0	PER BASIC SUBSCRIBER/YR
LEASED CHANNEL-LOCAL ORIGIN.	$	0.0	PER BASIC SUBSCRIBER/YR

PHASED DIGITAL CENTRAL REFRESH FICH PENETRATION

9. FINANCIAL ASSUMPTIONS,CAPITAL INVESTMENT & CASH FLOW

FINANCIAL ASSUMPTIONS

EQUITY COST OF CAPITAL =	30.00	PERCENT
DEBT COST OF CAPITAL =	8.00	PERCENT
EQUITY CONTRIBUTION =	20.00	PERCENT
OPPORTUNITY COST OF CAPITAL =	12.40	PERCENT
RATE OF INFLATION =	3.00	PERCENT
ADJ OPPORTUNITY COST OF CAPITAL=	9.13	PERCENT
ADJ DEBT COST OF CAPITAL=	4.85	PERCENT

CAPITAL INVESTMENT

YEAR		0	1	2	3	4	5	6
BASIC EQUIP	$		429014.	286010.	286010.	143005.	143005.	143005.
TICCIT EQUIP	$		1712855.	1141904.	1141902.	570952.	570952.	570954.
LOC DIST CTR	$	0.						
SUB-HEADEND	$	365000.						
HEAD-END	$	96111.						
TRUNK SYS	$	517994.						
FEEDER SYSTEM	$	916000.						
GEN EQUIP	$	5000.						
PRE-OPENING	$	46670.						
TOTAL	$	1946774.	2141869.	1427913.	1427911.	713957.	713957.	713958.

PROJECT CASH FLOW - NEGATIVE NUMBER IS CASH OUTFLOW POSITIVE NUMBER IS CASH INFLOW

YEAR	0	1	2	3	4	5	6
GROSS REVENUE		586961.	1501197.	2241123.	2785397.	3155859.	3525324.
VARIABLE COST		-671379.	-863929.	-1020814.	-1131062.	-1209540.	-1288020.
NET REVENUE		-84418.	637268.	1220308.	1654335.	1946319.	2237304.
ADDITION TO WORKING CAPITAL		-12354.	-6529.	-5252.	-3865.	-2626.	-2626.
CAPITAL ADDITIONS	-1946774.	-2141869.	-1427913.	-1427911.	-713957.	-713957.	-713958.
CASH FLOW	-1946774.	-2238641.	-797174.	-212855.	936513.	1229235.	1520718.

EQUITY CASH FLOW ASSUMING 80.00 PERCENT FINANCING AT AN INTEREST RATE OF 8.00 % ADJUSTED FOR 3.00 % INFLATION

GROSS REVENUE		586961.	1501197.	2241123.	2785397.	3155859.	3525324.
VARIABLE COST		-671379.	-863929.	-1020814.	-1131062.	-1209540.	-1288020.
NET REVENUE		-84418.	637268.	1220308.	1654335.	1946319.	2237304.
ADDITION TO WORKING CAPITAL		-12354.	-6529.	-5252.	-3865.	-2626.	-2626.
DEBT REPAYMENT		-377939.	-706422.	-969207.	-1166299.	-1297694.	-1429087.
BORROWED FUNDS	1557419.	1713495.	1142330.	1142328.	571166.	571165.	571167.
CAPITAL ADDITIONS	-1946774.	-2141869.	-1427913.	-1427911.	-713957.	-713957.	-713958.
CASH FLOW	-389355.	-903085.	-361206.	-39734.	341379.	502706.	662797.

THE MITRE INTERACTIVE CABLE ECONOMIC EVALUATION MODEL
A FINANCIAL CAPITAL BUDGETING PLANNING PROGRAM

PHASED DIGITAL CENTRAL REFRESH HIGH PENETRATION

10. COSTS AND REVENUES

YEAR		1	2	3	4	5	6-20	PRESENT VALUE-TOTAL	
SYSTEM REVENUES									
CONNECTION FEE	$	35216.	29082.	34150.	26680.	28814.	30949.		
BASIC YRLY	$	221999.	591997.	887995.	1109994.	1257993.	1405993.		
TICCIT YRLY	$	329745.	879319.	1318978.	1648723.	1868552.	2088383.		
COMMER-INTERACT	$	0.	0.	0.	0.	0.	0.		
PAY TELEVISION	$	0.	0.	0.	0.	0.	0.		
ADVER REVENUE	$	0.	0.	0.	0.	0.	0.		
CHANNEL LEASE	$	0.	0.	0.	0.	0.	0.		
TOTAL	$	586961.	1501197.	2241123.	2785397.	3155359.	3525324.		25752384.
SYSTEM VARIABLE COSTS (EXCLUDES AMORTIZATION)									
BASIC EQUIP	$	26061.	70350.	105525.	131906.	149493.	167081.		
TICCIT EQUIP	$	80420.	214454.	321680.	402101.	455714.	509327.		
LOC DIST CTR	$	0.	0.	0.	0.	0.	0.		
SUB-HEADEND	$	152450.	152450.	152450.	152450.	152450.	152450.		
HEADEND	$	14278.	14278.	14278.	14278.	14278.	14278.		
TRUNK LINES	$	42471.	42471.	42471.	42471.	42471.	42471.		
FDER LINES	$	79160.	79160.	79160.	79160.	79160.	79160.		
OVER-HEAD EXP	$	276220.	290767.	305250.	308697.	315976.	323254.		
TOTAL	$	671379.	863929.	1020814.	1131062.	1209540.	1288020.		10364591.
SYSTEM TOTAL COSTS									
BASIC EQUIP	$	81710.	217993.	326840.	408550.	463023.	517497.		
TICCIT EQUIP	$	301322.	803527.	1205290.	1506613.	1707495.	1908377.		
LOC DIST CTR	$	0.	0.	0.	0.	0.	0.		
SUB-HEADEND	$	248028.	248028.	248028.	248028.	248028.	248028.		
HEADEND	$	39445.	39445.	39445.	39445.	39445.	39445.		
TRUNK LINES	$	100597.	100597.	100597.	100597.	100597.	100597.		
FEEDER LINES	$	181948.	181948.	181948.	181948.	181948.	181948.		
OVER-HEAD EXP	$	282908.	299265.	314400.	318326.	325930.	333534.		
TOTAL	$	1236958.	1890702.	2416546.	2803506.	3066465.	3329424.		25752592.
REVENUE MINUS TOTAL COST								NET PRESENT VALUE	
REV-TOT COST		-649997.	-389505.	-175423.	-18109.	88894.	195900.	-208.	
REV-COST/P SUB		-203.02	-45.66	-13.70	-1.13	4.90	9.66	-0.00	WEIGHTED AVERAGE
REV-COST/T SUB		-324.84	-73.00	-21.92	-1.81	7.84	15.46	-0.00	WEIGHTED AVERAGE

THE MITRE INTERACTIVE CABLE ECONOMIC EVALUATION MODEL
A FINANCIAL CAPITAL BUDGETING PLANNING PROGRAM

PHASED DIGITAL CENTRAL REFRESH HIGH PENETRATION

11. PRESENT VALUE AND RATE OF RETURN CALCULATIONS

PROJECT RATE OF RETURN IS 9.13 PERCENT
EQUITY RATE OF RETURN IS 17.03 PERCENT

ASSUMED SALES VALUE END OF YEAR 10 IS $ 1250266.

DISC RATE	PROJECT REV PRES VALUE	PROJECT COST PRES VALUE	PROJECT NET PRES VALUE	EQUITY NET PRES VALUE
1 %	5641412E.	47344224.	9069904.	6293296.
2 %	5056376.	43362432.	7226944.	5359280.
3 %	4553568C.	39871168.	5664512.	4558624.
4 %	4113545C.	3679504C.	4336416.	3870304.
5 %	37291264.	34087728.	3203536.	3276586.
6 %	33921104.	31686240.	2234864.	2763058.
7 %	30956832.	29553056.	1403776.	2317466.
8 %	28341024.	27652368.	688656.	1926666.
9 %	26022520.	25954096.	71424.	1591266.
10 %	23969168.	24431824.	-462656.	1295143.
11 %	22137408.	23063552.	-926144.	1035286.
12 %	20500832.	21830320.	-1329488.	806654.
13 %	19034512.	20715984.	-1681472.	604992.
14 %	17716736.	19706064.	-1989328.	426687.
15 %	16529247.	18788512.	-2259265.	263662.
16 %	15456263.	17952880.	-2496617.	128260.
17 %	14484307.	17190112.	-2705805.	3264.
18 %	13601437.	16491939.	-2890502.	-108258.
19 %	12797576.	15851495.	-3053919.	-207952.
20 %	12063912.	15262753.	-3198841.	-297251.
21 %	11392794.	14720439.	-3327645.	-377365.
22 %	10777396.	14219658.	-3442262.	-449420.
23 %	10211916.	13756353.	-3544477.	-514284.
24 %	9691227.	13326997.	-3635770.	-572771.
25 %	9210764.	12928196.	-3717432.	-625607.
26 %	8766634.	12557264.	-3790630.	-673356.
27 %	8355216.	12211468.	-3856252.	-716670.
28 %	7973419.	11888615.	-3915196.	-755908.
29 %	7618506.	11586705.	-3968199.	-791526.
30 %	7288045.	11303969.	-4015924.	-823895.
31 %	6979792.	11038695.	-4058903.	-853341.
32 %	6691815.	10789467.	-4097652.	-880143.
33 %	6422373.	10554983.	-4132610.	-904562.
34 %	6169928.	10334113.	-4164185.	-926829.
35 %	5933021.	10125693.	-4192672.	-947139.

4.0 OPERATIONAL CONSIDERATIONS FOR INTERACTIVE TELEVISION

Since interactive television must compete for subscriber time with conventional TV and other educational and leisure-time activities, it is not enough to develop just the technology to deliver interactive services. Attractive examples must be identified, the means for their production developed, and the markets selected for the chosen services. These fundamental steps must be taken in the first, large-scale demonstrations of interactive television, with the awareness that the potential subscribers will help in the decision process, as they accumulate experience with interactive TV, and what it has to offer. It is desirable that the results of these first tests be generalizable to the broad spectrum of potential users. The early investment in interactive television programming will be extremely limited (in comparison with commercial television programming), and the operation and selection of the test site must maximize the benefit/cost ratio.

In this section, the major operational considerations for an interactive television trial are summarized. Later, in Section 6, operational recommendations for a "quick thrust" data-gathering experiment are summarized.

4.1 The Management Task

Management systems are needed to formalize the process of transforming ideas into operational services. For conventional TV, the need for management of program material development has not been required. The task of devising the mechanisms needed to develop

program materials for two-way systems has been deferred until the time when services were selected. That time is now, and the task is to require a mixture of pragmatism in the face of practical limitations and a flexibility that will allow the unexpected -- possibly unique -- interactive services.

The technology has been invented, developed, demonstrated, and evaluated; analysis has shown interactive television has the potential for viability. Meanwhile, the list of "possible" services to this communications-dependent society is growing rapidly. Management systems to handle the production and delivery of interactive services must be devised, developed, demonstrated, and evaluated, just as the technology has been.

Management starts by identifying the resources. The first interactive services will probably be based on existing program material. Vast libraries of film and videotape, both in the private and public domain, are available as a resource for interactive presentation. A second source of material is the growing body of educational programs designed specifically for computer control and display. This material has been developed for delivery within the school or college framework. Delivery into homes will require new management techniques.

Perhaps the most potent resources will be the users themselves. The ingenuity and enterprise of individual subscribers, local societies, and the community leaders to advertise, announce, claim, disclaim,

or, in short, to communicate, will very possibly develop useful, even wealth-creating services and functions.[14]

An NSF/MITRE review panel will monitor sources and delivery of services. It would be a serious mistake to settle prematurely on one particular way to utilize each resource, even if first trials are successful. The single, most powerful aspect of interactive television, properly interpreted, is the viewer's real-time response during or following the use of each service. The delivery services must be managed so that each subscriber's activity is logged.

Finally, the management system must provide rewards and motives, new markets must be developed. Analysis of subscriber usage and response for each class of service, plus the suggestions from users themselves, will form the basis for modified and expanded services.

4.2 Selection of Candidate Services

The selection of interactive services presents a considerable challenge. Many more aspects than those that make up an engineering experiment must be considered.

First, there is the question of the type and value of the interaction. The services include, among many others, instruction, entertainment, companionship, and employment, each piggy-backing, economically speaking, on the others. Each introduces value systems with separate, possibly conflicting criteria. Second is the question of interpreting the response, understanding the reaction of subscribers. Therein lies

[14]Thompson, Gordon B., Moloch or Aquarius?, Issue IV (February 1970).

our major indication as to the merits of the delivery system. In particular, the choice of services must be made with an awareness of the instructional and community fabric that may be affected.

The first of the two panels of specialists convened in June, under the chairmanship of Dr. Lloyd Morrisett, discussed interactive TV services from the vantage points of the panelists' expertise in communications and education, the social sciences, and programming for the print and television media. The panelists agreed that popularity and frequency of use should be our social indicators. The MITRE staff has investigated a number of potential impact areas, constituencies (the aged, preschool children, etc.), and activities (career education, health-service delivery), but the panel contended that pilot services directed to specific problems in such areas would not make the best use of the prototype distribution system. Special problems must have special programming, which is costly and time-consuming to produce, and must show progress in a specific situation that requires the development and then the interpretation of special social indicators.

The June panelists enjoined us from reinforcing the "duplex society" syndrome by providing interactive television supporting only the needs of a chosen few. Thus, earlier ideas of demonstrating the success of interactive television services by some specific improvement in a specific social service has been replaced by the general philosophy that interactive services must first compete successfully for the subscribers' time. The total package must appeal to people who differ widely in economic status, education, age, and ethnic background, before it can

become a practical carrier for special interest services. Tables V and VI list the June and August panels, and their suggestions.

We have made an exhaustive search of the literature concerning experiments and techniques that have been proposed to measure the usefulness and effectiveness of communications systems. While there is a considerable body of theory and philosophy concerning such measurement and forecasting possibilities, we have not found a technique that we could consider practical in the time frame we are trying to meet for the selection of the service options, system distribution options, and operational strategies.

It should be pointed out, however, that everything we have read reinforces our belief that computer-mediated interactive television can have a revolutionary effect on national communications. Interactive television incorporates the essential parameters for such a revolutionary capability. It provides access to everyone; it provides from within the communications media itself a mechanism (i.e., the common computer) for structuring and manipulating the material communicated. Thus, a common body of understanding and insight is furnished by the media for the communicators. Further, it provides from within the medium itself a basis for developing a concensus on the subject being addressed by those involved in the communications

While the time-shared computer has been recognized as a device that could support these desirable characteristics of a new communication system,

[15]Thompson, Gordon B., Moloch or Aquarius?, Issue IV, February 1970.

TABLE V

LIST OF THE JUNE PANELISTS AND THEIR SUGGESTIONS FOR SOCIAL NEEDS

Panelists	Affiliation
Mr. Franz Alina	Children's Television Workshop
Dr. C. Victor Bunderson	CAI Lab, University of Texas
Mr. W. Bowman Cutter	Cable Television Information Center
Dr. Bernard Gifford	New York Rand Institute
Dr. George Kennedy	High-Scope Educational Research Fdn.
Dr. Gerald S. Lesser	CTW and Harvard Grad Sch. of Education
Dr. Lloyd Morrisett, Chrm.	The Markle Foundation
Dr. Edwin B. Parker	Stanford Univ. Institute for Communication Research
Dr. Ithiel Pool	Political Science Dept., M.I.T.
Dr. John Riley	Equitable Life, New York
Dean Alvin L. Schorr	New York Univ. Grad Sch. of Social Work

Social Needs Suggested	
INSTRUCTIONAL TRAINING:	For both teachers and parents.
CAREER EDUCATION:	For both children and adults.
PARTICIPATORY DEMOCRACY:	Covering contemporary community issues.
READING AND MATH INSTRUCTION:	Both basic and remedial.
HIGH-SCHOOL EQUIVALENCY:	Covering vocational training, tutoring for "home-bound" persons, and interactive parents-children (game-type) activities.
EMPLOYMENT-OCCUPATION GUIDANCE	
CONTINUING EDUCATION	
DAY-CARE SERVICES:	Reinforcing para-professional preschool child care personnel.
MEDICAL-INFORMATION	Both preventive and emergency.
CONSUMER-CITIZEN ASSISTANCE:	Covering day-to-day living concerns such as the legalities of wills and contracts.
PARTICIPATORY GROUPS INTERFACE:	Such as shut-in widows, high-school dropouts, etc. -- all of those who have recurring needs that are not being met satisfactorily at present.

TABLE VI.

LIST OF AUGUST PANELISTS AND THEIR SUGGESTIONS FOR "POPULAR" SERVICES

Panelists	Affiliation
Mr. Lewis Freedman	Hollywood Television Theater
Mr. James A. Lippke	Broadcast Management/Engineering
Dr. Lloyd Morrisett, Chrm.	The Markle Foundation
Ms. Theodora Sklover	The Open Channel
Mr. Robert D. Smith	WNVT (Channel 53), Northern Virginia
Mr. Charles E. Tate	The Urban Institute

Popular Services Suggested

AUCTIONS

Real time live or elapsed (bidding will close at noon).

COMMUNITY FORUM

Consensus recognition and dissemination by the computer - grouping pro and con community questions.

1001 ANSWERS

Pooled community experience on "how to," "who to," "when to," programmed or bulletin board format. An experience catalog.

EVERYDAY THERAPY

Interpretation of dreams - discovery of people with similar problems - grouping for mutual assistance (with anonymity if required) - sensitivity tapes.

EQUAL TIME FOR THE CONSUMER

Legitimate gripe board exposing "less than better" business practices.

RELIGION

Contributing to and sharing liturgical experiences.

THEATRE GAMES

Role playing - simulation of results from alternate courses of action (domestic and/or community).

MUSIC AND DRAMA

Computer organ in your home - sings along - play readings - poetry workshops.

WORD GAMES

Scrabble - anagrams - password free - word construction.

GAMING

Poker - Black Jack - new games unique to TV - playing versus the machine or other people.

(continued)

TABLE VI (continued)

COLLECTORS NETWORK

Sharing the enthusiasm of possession.

PHYSICAL FITNESS/DIETING

Specific exercises/menus for subscribers' problems.

AUDIENCE PROFILING

Mechanism for response to services - who's new in town, their skills and hobbies -- community resource data bank.

ACCOMMODATION

To rent or sell - house sitting -- exchanges.

SWAP/THRIFT SHOP

Staffed by volunteers for charity, hospital funds, etc.

RAINY DAY ACTIVITIES

Plans and directions for games and projects to fill children's shut-in hours with fun learning activities.

the question of access to such capabilities has heretofore not been successfully addressed. Now, computer-controlled interactive television provides many points of access, making them available to a wide range of people and institutions. The system we are demonstrating in Reston (and will better demonstrate in Phase II) provides these essential ingredients for the "ideal" communications system, whether or not a truly successful set of services can be immediately identified.

The second panel, which met in August, was asked to generate ideas for the following:

- Computer Content: Entertainment and informal instruction programs unique to the interactive delivery mode.
- The Communications Function: The computer-mediated format in which new communication links between people may be developed in community life, companionship, and personal problems.

The panelists' suggestions and priorities are discussed in Volume III. Tables III and IV in this report summarize the applications developed by the panels. In addition, the August panel strongly recommended that:

- Representatives from the fields of education, print media, and the cable and TV industries should be selected and organized into a working team to provide a sounding board for a continuous program.
- MITRE should start negotiating now with pilot-city candidates, and a site should be selected as soon as possible. Existing

institutions in the candidate pilot-city communities should be used as a major source of ideas on applications.

In summary, a considerable body of material has been documented concerning potential services. It is time to move the program on from generalities to specifics, to proceed to an empirical program in an operational environment, starting with services subjectively chosen. Services for families in Reston during the next seven months have already been chosen. Table VII gives an attractiveness rating to an important subset of the panelists' suggestions for services in Phase II and III.

4.3 Selection of Candidate Sites for an Eventual Urban Center Trial of Interactive TV Services

In the selection of candidate Phase III implementation sites, the requirements of a successful demonstration and evaluation must be balanced against the relevance of these requirements to the needs of other U. S. cities. Accordingly, summary information has been compiled to:

- Identify all cable systems in the United States that have the technical capability to accommodate interactive television demonstrations, or that will have such a capability by the summer of 1974, when Phase III of our study will begin.[16]
- Provide certain additional information about the system, its operation, and the city in which it has been or will be built that can serve as a basis for preliminary narrowing down of

[16] Pilot Projects for the Broadband Communications Distribution Systems, Malarkey, Taylor, and Associates, November, 1971.

TABLE VII

RANKING OF SERVICE PACKAGE FOR HOME DELIVERY

	Popularity	Legal Problems	Inst & Political Problems	One Time Cost	Early Technical Feasibility	Social Impact	Total
Civic Meetings/Participation	2	0	-1	1	1	3	6
Bulletin Board	3	0	1	1	2	1	8
Educational Games	2	1	0	1	2	2	8
Fun Games	3	1	1	1	2	0[B]	8
Experience Catalog	2	1	-1	1	1	1	5
Person-to-Person or Group Meetings	1	0	0	-1	1	1	2
Auctions	2	-1	-1	1	1	-1	1
Educational Simulation	2[A]	1	0	-1	2	2	6
Employment/Accommodations	2	1	-1	-1	2	1	3
Drill & Practice	2[A]	1	2	-1	2	1	7
Tutorial CAI	2[A]	1	1	-1	0	2	5
Medical/Therapy	2	-1	-1	-2	1	3	2

[A] These are captive audiences - a true popularity ranking might be lower

[B] Measuring the social utility of companionship is difficult - some might rate this item very high, however.

candidate sites to those that should receive further study before final choice of a site for the Phase III demonstrations.

The Federal Communications Commission's new cable rules, promulgated on March 31, 1972, require that new cable systems in the nation's top 100 market areas have two-way capability. The relevant section of rules reads:

> On review of the comments received and our own engineering estimates, we have decided to require that there be built into cable systems the capacity for return communication on at least a non-voice basis. Such construction is now demonstrably feasible. Two-way communication, even rudimentary in nature, can be useful in a number of ways -- for surveys, marketing service burglar alarm devices, and educational feedback to name a few.
>
> We are not now requiring cable systems to install necessary return communication devices at each subscriber terminal. Such a requirement is premature in this early stage of cable's evolution. It will be sufficient for now that each cable system be constructed with the potential of eventually providing return communication, without having to engage in time-consuming and costly system rebuilding. This requirement will be met if a new system is constructed, either with the necessary auxiliary equipment (amplifiers and passive devices) or with equipment that could easily be altered to provide return service. When offered, activation of the return service must always be at the subscriber's option.

As can be seen, these rules require no more than narrowband, non-voice return capacity. As a practical matter, however, they are likely to be surpassed in most or all new cable systems in the top 100 markets by the installation of equipment from one or more of the major manufacturers that provide some 20MHz of return capacity.

FCC's rules will produce a new generation of cable systems in major market areas, all having two-way capability. In fact, a number of cities that had started franchising proceedings before the rules were

promulgated were already planning on two-way capacity, and have so specified in their hearings, or had recently granted franchises, ordinances, etc. In addition to installed two-way systems, therefore, we can give consideration to a certain number of sites where franchises have been granted, or soon will be granted, franchises that are likely to have sufficient installed technical capability two years from now to make them eligible. The total number of systems discussed in Volume III is twenty-nine. Of these, eleven are prime candidates:

- If a site with installed capacity is preferred:

  Akron, Ohio
  Orland, Florida

- If a large city is preferred:

  Houston, Texas
  San Antonio, Texas

- If a medium-sized city, with "big city" urban characteristics is preferred:

  Gary, Indiana
  Dayton, Ohio

- If a medium-sized city with "suburban" characteristics is preferred:

  Arlington, Virginia
  Sunnyvale, California

- If a "new community" is preferred:

  Reston, Virginia
  Jonathan, Minnesota

- If a city with contiguous suburbs or more affluent neighboring communities, all franchised to the same operator and interconnected, is preferred:

  Lynn, Massachusetts
  Orlando, Florida

- If black ownership is regarded as important:

  Dayton, Ohio

These sites have been ranked by applying comparative scores, based on a subjective analysis of their standing in various categories. This is a supplementary technique which provides an additional guide to the site selection process, but which should not be the only basis for a site recommendation. One important factor concerns the adaptability of existing and designed system configurations to the hub concept. A conventional one-way service hub would serve from two to five times the number of subscribers on an interactive service hub as is described in Section 2.1. If distribution systems do not develop along the "mini-hub" lines, we will still be able to offer TICCIT on operational systems when frame-grabber prices drop. For example, some have more extensive medical facilities; some have more extensive educational facilities; some have better developed cultural facilities; some have better developed community group and civic action groups; some have better facilities for communicating municipal and social information and services to their residents; some have demographic characteristics that might be conducive to better testing of certain types of demonstrations.

5.0 DEMONSTRATIONS OF INTERACTIVE TELEVISION

Showcase demonstrations of interactive service concepts have stimulated feedback from communicators and the communications industry and have been a catalyst for continuing developments in the technology and applications of interactive television. Demonstrations have been the primary vehicle for developing both the hardware and the program content from concepts into practice. Future demonstrations will carry interactive television from the laboratory into the home, from an experiment into a utility.

MITRE is soliciting industry to join in the technological developments and is welcoming social science centers to join in the evaluation of the social impact of interactive services. Interactive television is a system of concepts (see Table VIII), not a particular collection of hardware and software. At different periods, each concept must be tested individually. A goal for this study is to develop a plan (a defacto statement of feasibility) that, when put into practice, will demonstrate that the combined concepts delivered to schools and homes simultaneously are both easy to utilize and valuable to the subscriber.

This section reports on the history of these demonstrations, their impact, and the new Reston demonstration content that has been developed under the NSF grant.

TABLE VIII

Demonstrating TICCIT: The necessary tasks and desired effects.

Concept	Tasks	Effect
Time Shared	Configure a space and time multiplexed delivery system to optimize the major first and continuing cost items.	Mass distribution with economic viability for realistic rates of revenue.
Interactive	Provide audiovisual/keyboard signal input capability from the subscriber's home for real-time program content control.	Subscriber control, Discovery of Consensus.[11]
Computer Controlled	Interpret and respond to the input signals using dedicated on-line stand-alone mini-computers and storage peripheries.	Unique, fast, dedicated display production, Increased Common Information Space.[11]
Information	Manage, update, produce and store the service data base.	Dealienation, Access to Stored Humane Experience.[11]
Television	Deliver computer output to unmodified regular b/w or color home television receivers.	Two-way audiovisual communication.

[11] op.cit.

5.1 1971-1972 Demonstrations at Reston

From July 1971 to June 1972, demonstrations of conceptualized services delivered via TICCIT over the Reston Transmission Company's cable system were attended by over 1,800 people - from North and South America, Europe, and Asia.

The demonstration was held in a home setting in order to simulate the environment of a typical user but it was the lecturer who held center stage. The MITRE demonstrator handled the interaction while the audience viewed passively. The visitors (in the majority, male, 45, white, and professional) were not in their typical home-user role during the demonstration and therefore could not provide a source of data on the home use of the system.

The content of the data display, although necessarily limited, was designed to reflect future potential for the system. Classified ads, television, and phone directories were used to demonstrate inexpensive mass storage capabilities. The desk calculator and community information material illustrated practical home services, and the limited computer-assisted instruction and medical information gave a sense of personalized services with high social utility.

Meaningful levels of interaction between user and system were developed by school children. These students ranged from grade one to grade eight (a few high school and college groups also attended), and the results were very positive. Several important aspects of our system became apparent from these demonstrations. Children,

even at the beginning, are not afraid or shy about using the equipment. Once given simple instructions (or a simple demonstration), they work quickly and easily and have a high rate of retention. One group used the system in early July; when they used it again in September, the children needed no refresh instructions on how to operate the terminal. This experience was in line with other experiments with CAI at the elementary school level.

5.2 The Impact of TICCIT-Demonstrations

The visitors to the Reston demonstrations have represented every major government department, a spectrum of educational institutions from research laboratories to elementary and preschool operations, municipal, financial, and citizen s groups; foundations; the media; and domestic and international corporations. Among those attending were the President of COMSAT, the Chairman of the Canadian FCC equivalent (CTRC), the Director of Cable Television Bureau of the FCC, the President of Goldmark Communications, and the President of TVC. (Appendix A lists the organizations and institutions represented at demonstrations.)

The reaction of visitors has been generally enthusiastic and constructive. Visitors not only have assessed the potential TICCIT contribution to their field, but most have also shown excitement over the personal involvement that the program offers. "When will I be able to have this in my home?," is probably the most frequently asked question.

The demonstrations have influenced the communications industry internationally. This is clear from discussions with Canadian, French, and Japanese manufacturers and with government officials after they have visited the demonstration. Here in the U.S., for example, one of the largest electronics manufacturers in the country has indicated that the Reston demonstration had a major impact on its board of directors' decision to enter the communications field. We have reason to believe that the demonstration also influence the Office of Telecommunications Policy and the FCC toward adapting a policy encouraging two-way cable development. The evolution of the MITRE two-way demonstration is limited prototype experience and stimulus to industry that encourages the provision of those products that support mass dissemination. Japanese manufacturers express the most immediate interest. Shortly after a high level delegation of their industry and government leaders visited, Japan announced a $10-million development program in this field.

Demonstrations are influencing future social science experiments. Dialogues are turning into plans to "piggyback" on the Reston testbed. Universities are funding programs to develop ideas in participatory democracy, continuing education, clinical telecommunications, programs for the aged, and services for the disabled.

5.3 A New Reston Demonstration Developed Under This Program

A second-generation program, covering the original, plus some major new content and technological and economic improvements, was

developed under this grant. This program was assembled because the demand for demonstrations continues and the technology has progressed dramatically since the original demonstration was started. The resolution of the alphanumeric display has improved, and a graphic capability and variable fonts are now available in seven colors over standard TV channel bandwidths. Both still and moving gray-scale video segments can be interspersed between the computer-generated alphanumeric frames.

The new program content has added the following materials:

- Data retrieval screening to suit a subscriber's unique needs.
- Interaction between subscriber and computer memory bank during an auction.
- Educational games.
- The concept of a Televisit by a physician.
- Retrieval of gray-scale photographic data.
- Surrogate gambling.

Each of the above represents an embryonic program that could be developed to provide an interactive service similar to those in the original demonstration program listed in Figure 2.

Selective data retrieval is illustrated in the new Reston demonstration by an individualized employment search program. The subscriber answers as many as he chooses from a list of questions about his education, previous experience, sex, salary or wage requirements, and preferred work hours and location. His answers determine which

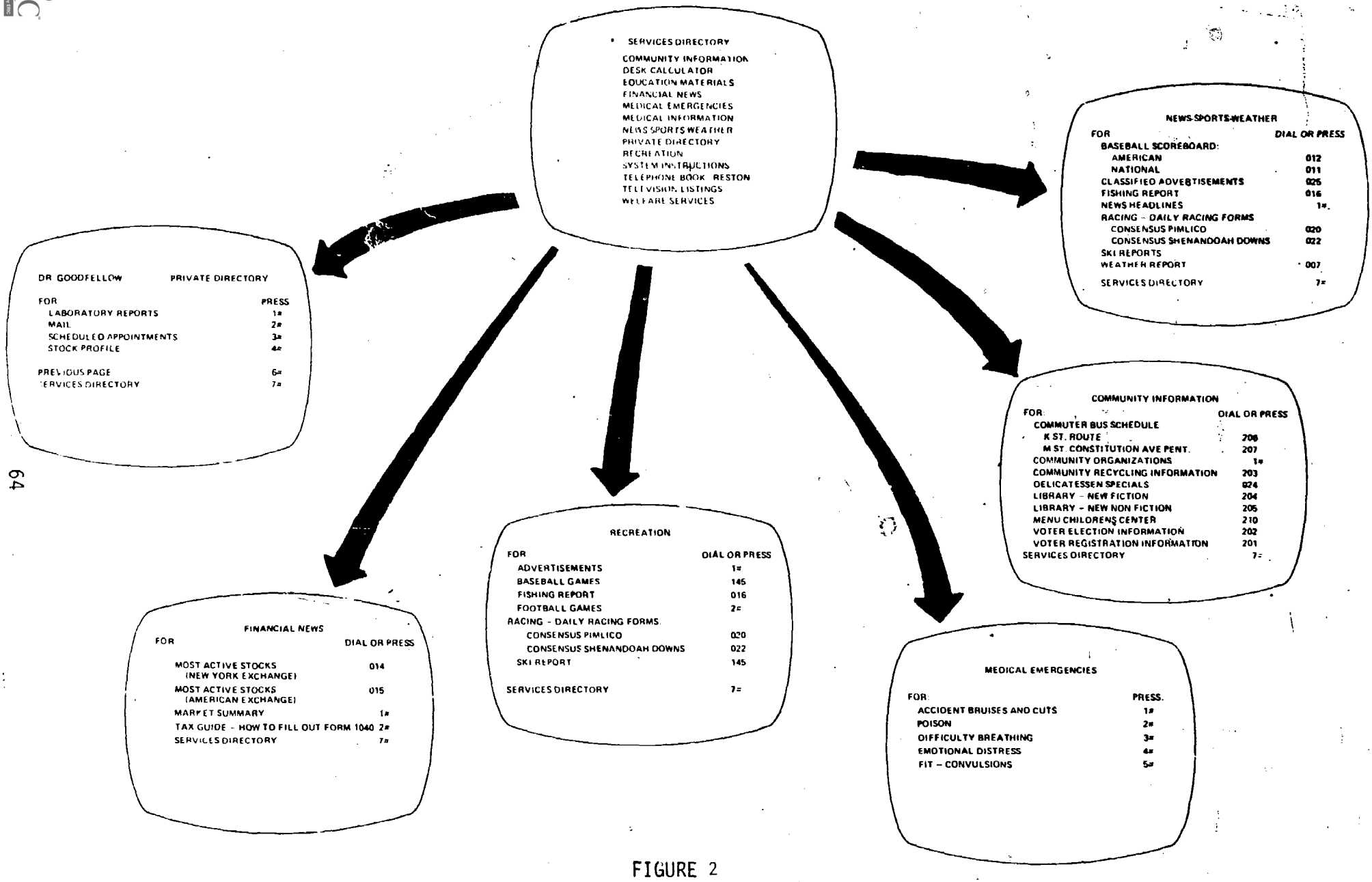

FIGURE 2

LIST OF SERVICES FOR ORIGINAL DEMONSTRATION PROGRAM

jobs in the data bank meet his broad requirements, these are then displayed for the subscriber to browse through. Adequate space is available to describe the job environment, show pictures of the products or the office, the best commuter routes. A distinction is made between this full description, stored once and selected to suit the subscriber's particular needs, and the space-constricted newspaper classified advertisements that are stored thousands of times, in the hope a match with a chance reader will be productive.

The auction concept is developed to demonstrate multi-terminal, real-time interaction with the computer memory bank. Having established one's identity and credit rating, an automatic credit limit, if desired on bidding, each subscriber can view the object to be auctioned. The current high bid and the time of the auction closing are displayed on the screen. Bids are entered via the keyboard. The exercise exposes the problems of subscriber identity and management from the headend of several simultaneous remote terminals and their interaction.

Educational games (any past-time in which skills of observation, comparison, memory, etc. are required) provide a competitive framework for learning experiences, either among subscribers, or between subscriber and computer. An example is a word game where a series of three-letter words must be unscrambled with points awarded for speed and accuracy.

The physician's Televisit is an example of communication replacing transportation, an important concept in its own right. The social

implications of the house-to-clinic video link obviously extend beyond medicine to community communications in general.

The full, alphanumeric keyboard is necessary (and available) for services that require subscriber-typed message inputs. The program is designed, however, to allow the majority of the concepts to be controlled by a standard, 12-button touchtone telephone pad. This is in line with the general philosophy behind the demonstration design, simplication of the terminal equipment in the subscriber's home.

6.0 PLANS FOR THE IMMEDIATE FUTURE

The preparation for extended Phase I is outlined in this section. These are the short-term plans that will provide the technical and sociological experience that must be gained before a design for a major urban environment can be realistically attempted.

6.1 Services Planned for Multiple Home Delivery in the Next Seven Months

It is MITRE's recommendation that preliminary trials of interactive television should concentrate on:

- Instruction delivered into schools and homes;
- Community communications and social services delivered into homes.

In broad terms, these two recommendations represent services directed at captive and non-captive audiences, respectively. The emphasis for our immediate plans will be on instruction to audiences that have a motivation to view and learn, or at least who have had their time apportioned so that they will attend to the program. In contrast, services for a non-captive audience must be designed to attract and hold an audience in order to serve it. The techniques for design of social services, compared with those for instructional services, require a much different discipline and approach to the material.

Discretionary time of individuals, after all the "necessary" aspects (including child raising, religion, etc.) of life are accounted for, is mostly spent in companionship, entertainment, problem solving and self-improvement, shopping, and (usually to a much lesser extent) community involvement. Because of the necessarily limited audience size, it is

our intention to overlap some of these existing human desires and behavior patterns with our first selection of services. In other words, improving the quality of life (not just the convenience of life) through these potential services means serving individual desires, even though they are unfulfilled and even unrecognized.

As detailed elsewhere in this report, the initial set of services can offer no more. Feedback from the community is vital to adapt the initial service offering to the needs of the community. This, however, does not decrease our responsibility to create services with great sensitivity and ingenuity. Format, as well as intent, in our opinion, will greatly affect usage and acceptance. In the past year, a very minor effort has gone into creating the content of our demonstration programs in social service. To our program, we have now added a number of creative individuals skilled in various specialities, who are dedicated to creating programs in a wide range of service categories. (Note that teleshopping, telebanking, and telereservations are not included. MITRE recognizes that, in a fully operational system, these commercial services potentially add significantly to the economic viability of an interactive television operation. However, MITRE believes it is administratively premature to mount such services at this time.)

6.1.1 Instruction

The initial services menu will include a major data base of instructional material. In particular, we plan to provide services to Stanford University's (Professor Suppes) Computer-Assisted Instruction program of elementary schools of drill and practice in arithmetic,

reading, and grammar. Based on talks with officials of the Fairfax County Public School System, the three elementary schools in Reston will, in all probability, make major use of this material. The major innovation of the Reston school program is that not only will approximately 15 terminals be utilized in each of the three elementary schools, but that the same material will be available to the children in their homes. The computer will keep track of students' progress in both the school and home environment.

The second major instructional service will be providing teachers a special, extremely simple programming language that will allow them to generate special instructional routines on the TICCIT computer directly from the remote terminals. This interactive programming languaged, called "Mr. Computer," has been used in New York State with great success by sixteen schools for the mentally retarded. The language was developed by General Electric Company and is so simple an average teacher learns to program it in approximately two hours.

6.1.2 Companionship

For the house-bound, the very old, the infirm, mothers with small children, and the "urban isolated," companionship services may prove to be the most important of all. Generations no longer live together in the same household, and the neighbors in an apartment building do not know each other. The computer can provide a variety of services, some of which emulate the kind of social information available in a small community:

- A dynamic bulletin board of who wishes to do what. For example, who wants to play pinochle at 8:00 tonight. Skills, hobbies, sports interests, reading to preschool children -- each is an example of possible mutual interest that might stimulate community members to be more aware of each other, and could lead to person-to-person contact.
- Communication via keyboard that allows anonymous person-to-person communication. This might be important for discussions of personal problems, and possibly, a format for the equivalent of encounter therapy.
- Games that can be played on a person-to-person basis via the interactive television communications facilities. Checkers, bridge, and many other games could be played by people who are either unable to leave their households, or find it inconvenient to meet in person.

6.1.3 Community Ombudsman

In the past, both precincts of a large town and small towns usually had some individual to whom one could go for help in confronting the confusing bureaucracy of federal, state, and local government. Many "services" now provided by the government were provided by individuals. Today, the local alderman, "boss", or fixer, is unknown to the urban mobile population. Worse yet, finding out the service, nature, availability, and government organization to contact when one has problems is information which, in our society, has been taboo to advertise. For

example, one does not see any advertisement, either on television or in the newspapers, or in the display ads of the classified yellow pages, for the services of the small claims court. One can speculate, in this particular example, that this is one reason why the small claims court is now used primarily for merchants to seek redress against a client, instead of, perhaps, the vice-versa. There are almost endless other examples of community services that are difficult for the average citizen to interface with. We think this is especially true for the poorly educated and semi-illerate. The computer, in these cases, can be programmed to ask the user what his problem is, or perhaps present him with a series of indexes. After narrowing down to a specific agency, the computer presents information on detailed procedures for obtaining assistance, and the details of what services can be provided. We think the difference between this approach and searching and calling through the government bureaucracy is striking.

6.1.4 Community Soapbox

The limited space in "letters to the editor" in local newspapers, and the even more limited space on television editorials in today's media provides no real substitute for the influence an individual in a small community can bring to bear. Here is a medium for everybody -- poets, artists, philosophers. Creative ideas available to the computer data base can be perused, on demand, by those who are interested in hearing them. The low expense of a single-time storage in a computer data base enables the establishment of a communications media for which there is no substitute in today's society.

6.1.6 Community Coherence

People do not participate enough in community affairs. Often it is inconvenient, even embarrassing, for a citizen to express his views, say in a hearing discussing the widening of a public road. when a much broader cross-section of community opinion feels otherwise. We think it is at least worth exploring whether it is practical to expose differing opinion in real-time community meetings. An alternative is non-real time means to achieve similar ends. Experiments in "participatory democracy" could be mounted on a test-bed, interactive system, such as the one planned for Reston. A member of the TICCIT staff, a lawyer, is expected to seek practical formats for such an experiment.

6.1.7 Subscriber Design of the Medium

There is no reason to believe that we in the "ivory tower" will come up with the most relevant programs for the computer. For example, the teenage hotline or suicide hotline, or the call-in radio talk show, were not invented by the telephone company. Neither was the Beatle culture invented by the inventor of the long-playing record. For this reason, we plan to allow subscribers in their homes to program the computer to generate new services of their own design. The means to do this will be a possibly expanded version of "Mr. Computer," a very simple language to allow the ordinary person to program the computer. Not only might members of the community program their own little CAI programs, but an endless list of possibilities is opened up. For example, individuals might put "how-to" information on recipes, bird identification, or other material, into the computer.

6.1.8 Health Care

A new category of health institutions, called a "health maintenance organization," has recently been opened in Reston. It is sponsored jointly by Georgetown University Hospital and various federal grants. Its charter is to provide not only primary, largely prepaid health care services for the residents of Reston, but to seek new ways to maximize the efficiency of health-care workers, using such approaches as paramedics and sophisticated computer and communications technologies. The director of this organization, Dr. Sehnert, and HEW's Health Service and Mental Health Agency are both interested in exploiting interactive television to tese the system's efficiency in maximizing health-care delivery efficiency. In particular, services such as doctor-in-the-office to patient-in-the-home two-way televisits, health-problem screening, and "triage" with the interactive computer in the home, and problem oriented medical record data bases are being seriously explored for use on the Reston TICCIT system.

In the development program for generating the above services, it is expected there will be a wide range of needs to meet, and courses with a variety of funding agencies.

6.2 Management and Service Production Delivery

The tasks supporting the delivery of services into subscribers' homes in the first test-bed trial of interactive television had been originally planned for Phase II. Now they have been advanced. The simplification achieved in the home terminal equipment during this

study period has greatly increased the potential number of subscribers that interactive television may reach from the start. Our decision, during the immediate future in Reston, is that we should capitalize on this larger data base for social impact measurement.

The management of the service production and delivery system starts with the question: What should be the source of the services: The June panel emphasized that services should be chosen as much as possible from existing data bases, rather than spending time and money in generating original programs. New programming should be limited to community-centered activities, such as weather reports, bus schedules, local entertainment, garage sales, or auctions.

When the content is ready -- that is, a weather report has been written -- the management software must be generated before the services become available. CAI that has run successfully elsewhere must be converted for delivery by another system. As local CATV origination programmers have discovered, the service source is most often the community itself. The necessary additional software tasks are those that provide the delivery function.

The next question is: How will subscriber and experiment interface? It is vitally important that communication channels between the users and the suppliers be visible, flexible, and above all, easy to use. Channels must be continuously in effect, and must include an inquiry line not dependent on the system. Such a heuristic and responsive program will also require professional interviewing and social surveys.

We plan to utilize the system itself to monitor usage, and to collect general statistics and opinions through multiple-question answer formats. These broad base inputs will be complemented by in-depth evaluations of random subscriber responses.

It is estimated that at least 1-1/2 hours per household of interviewing time will be required over the course of the development phase; one-half hour when the keyboard is installed, to get background data and to give instructions; a second, in mid-stream to get general usage information; and a final interview to complete the usage information and collect summary contents when the keyboard is removed. If 1,000 homes are involved, some 200 man-days of interviewing time will be needed.

The large-scale home trial will last for a minimum of two to three weeks. But a few hundred homes will be allowed usage for months, and it is expected that they will pay fees for the service. In a short period, the results may only reflect the novelty; a longer interval should give a better estimate of how people would regularly use this medium.

For the early implementation of interactive services, the home telephone will be the input keyboard. Twenty simultaneous lines on the computer could allow approximately four hundred subscribers to use interactive services each day for half an hour (assuming a ten-hour day). The actual demand profile will be evaluated continuously as a function of the services offered. Such characteristics of the system are fundamental to the preparation for the Phase II market test.

The size of the effort and the varying work schedules for the survey indicate that a small field office should be established for administrative purposes. Such a field site would support maintenance in addition to providing the demonstration with a closer tie to the community.

6.3 An Evolutionary Computer System Design

The present TICCIT demonstration must be reconfigured and expanded to provide a variety of interactive services to many simultaneous users. The presentation is now designed for briefing demonstrations, with only one user on-line at any time, and a small data base (32,000 word core--no ability to access disk storage). There are a number of ways in which the present system can be expanded to satisfy the extended Phase I requirements (20 simultaneous users and five to ten million characters of storage). Our design approach is guided by two additional goals; first, the system must be expandable to 100+ simultaneous users, without reconfiguration, so that there will be no need, during Phase II, to start all over with the hardware and software design. Our second goal is to make maximum use of the investment made by NSF in our community college TICCIT operating system software. Thus, we selected a hardware configuration that is well-suited to the demands of interactive television, while also being compatible with the operational features of the unique operating system we are developing (i.e., the only operating system for a minicomputer that can support over one hundred simultaneous users).

Figure 3 shows the new design for the Phase I operational system. The computer load is split between two processors: one at MITRE's McLean, Virginia offices; the other at the Reston Transmission Company's headend in Reston, Virginia. The two processors are connected with a full duplex, 4800 band, telephone data line. The communication processor in Reston accepts keyboard inputs from users, performs simple editing on the input, packs the input into messages, and sends the messages to the data base processor via the telephone data line. In addition, the communication processor accepts messages from the data base processor, and, under its command, causes the character generator to output specified TV screen displays to specified users. In a like manner, the communication processor causes the random-access picture file to retrieve pictures and send them to appropriate users. The magnetic tape unit, console CRT, and fixed disk are included to allow a direct approach to software updating and correcting. The communication processor CPU is a Nova 800 minicomputer, as is the data processor's CPU.

The data processor accepts messages from the communication processor, retrieves user data and programs from its moving head disk data base and user file, and then generates a response message that extends to the communication processor. The line printer console CRT and magnetic tape unit facilitate the generation of new application programs on the system when it is off line.

Figure 4 shows the interconnection of refresh memories to the cable, the character generator, the refresh control electronics, and

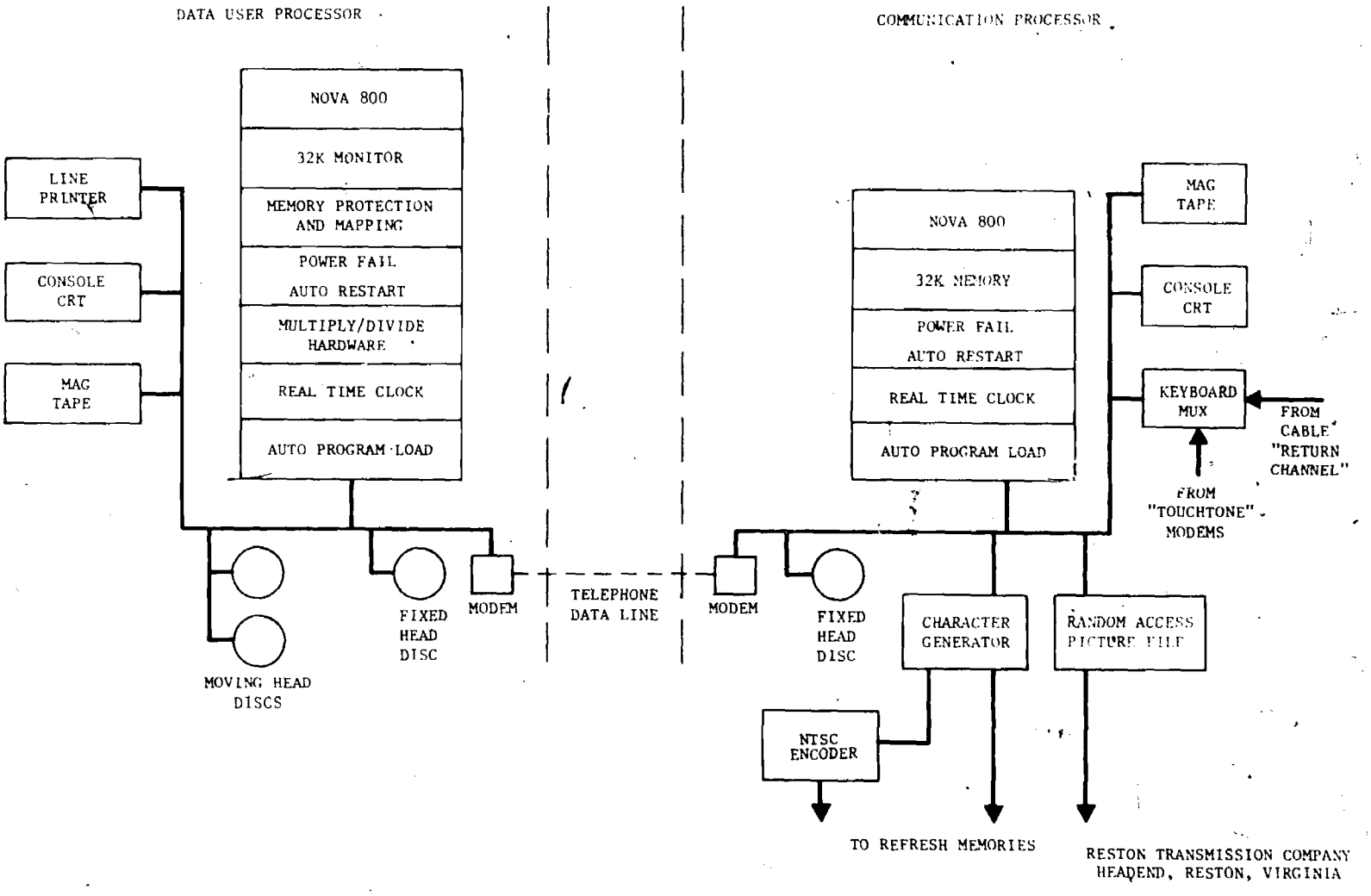

FIGURE 3
RESTON PHASE I COMPUTER SYSTEM

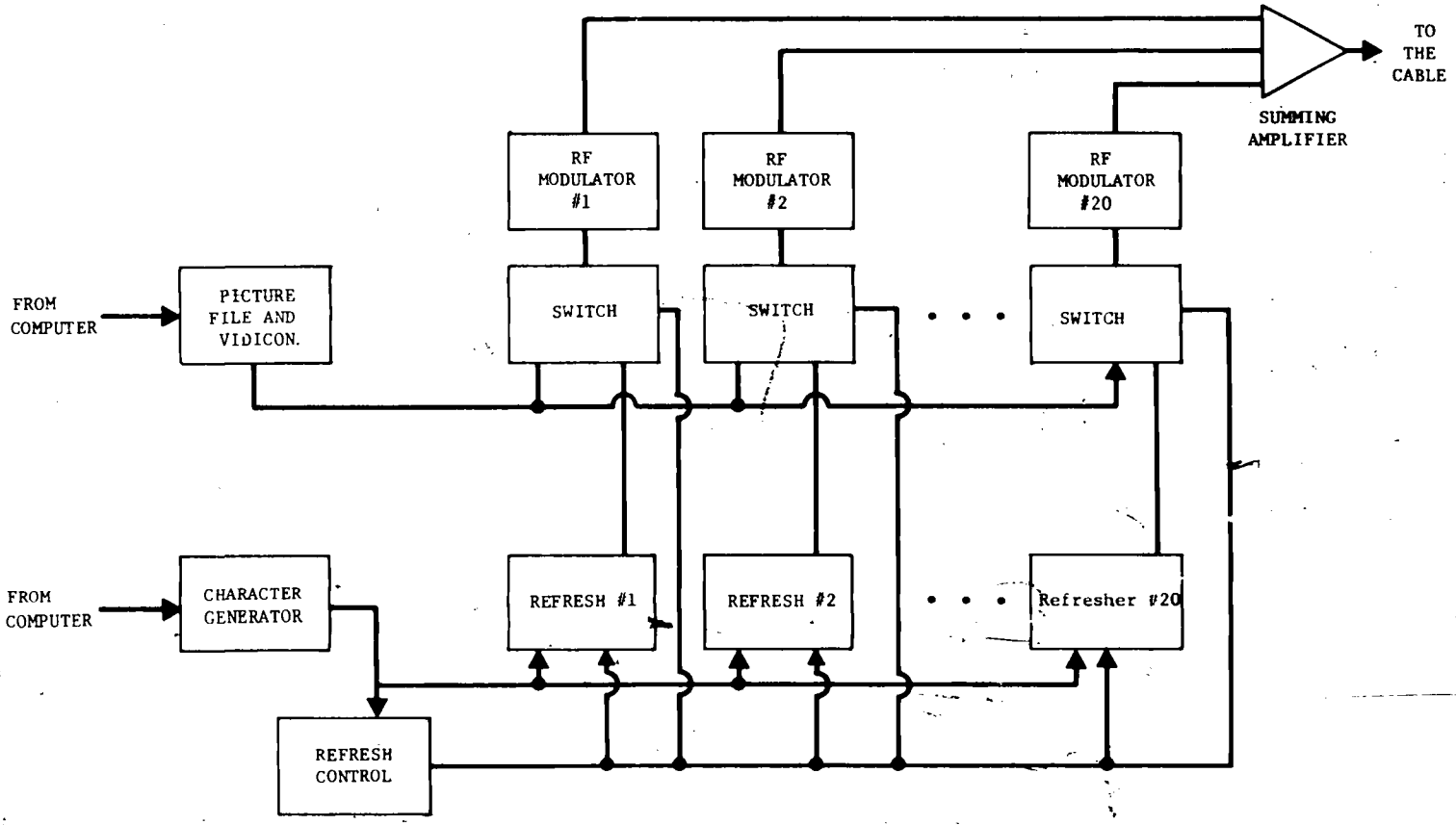

FIGURE 4
SIMPLIFIED BLOCK DIAGRAM OF PHASE I
PICTURE GENERATION HARDWARE

the picture file. The refresh memory can capture and hold a picture output by the character generator in one-sixtieth of a second. There is one refresh memory associated with each active user in the system (in Phase I, there are twenty refresh memories). The output of each refresh (a composite video signal) is modulated and placed on a channel on the cable. In Phase I, the modulated output of ten refresh devices will go on Reston's cable "A", and ten on cable "B" on VHF channels not now used, and on mid-band and super-band channels that are not used. A user will be directed, when he logs on the system, to tune his TV set (or a set-top converter, in the case of mid-band and super-band channels) to the channel of an available refresh memory. The picture file in Phase I will be time-shared over all users.

The refresh memory is a solid-state digital MOS shift register, consisting of approximately ninety thousand bits. This device has excellent resolution and reliability.

The character generator has a programmable character set and can equally well generate graphics and alphanumeric displays. Identical units have been fabricated in the community college program and are operating successfully.

The refresh control electronics select the refresh to capture the output of the character generator, as well as control the switching of picture file data to the modulators.

The modulators convert base-band, composite video to standard radio frequency television signals. The outputs of the modulators are

summed and placed on twenty channels of the two cables in the Reston system, along with standard, over-the-air broadcast television signals.

The picture file allowing random accessing of gray-scale displays, a moving-head, analog disk memory, with an access time of approximately one-tenth of a second,will be used to perform this function. New pictures may be inserted simply by placing them in front of a TV camera and pressing a button. With this simple process, they are automatically recorded on the disk and may then be retrieved on the computer control.

The Phase I system is intended to deliver interactive television services to any home with Reston Transmission Company's cable system. At any time, up to twenty homes may be simultaneously using the system. As the system grows in Phase II, it will support 100 simultaneous users. Only small changes will be necessary--primarily, the addition of another moving-head disk drive and the addition of eighty refresh memories and modulators. With the advent of more personalized services, privacy will be required. A subscriber must be confident that the information he stores will not inadvertently or purposely be displayed on another's screen. Scrambler techniques in conjunction with pay TV are being developed that offer protection by a magnetic card that serves as a means of identity. Such devices would be incorporated for trials and evaluation.

As configured, the Phase I and Phase II systems will be so similar that application software generated during Phase I will run without

modification in Phase II. In addition, the Interactive Television operating system will need only insignificant modifications of the Phase I and Phase II configuration to deliver the community college CAI into any cabled Reston home. The Phase I design, therefore, meets all of our goals.

6.4 Software

Just as the computer hardware design is premised on future expansion, so is the software design. Most software products developed for the Reston Phase I program will be used in subsequent phases.

The software required for an interactive television system falls into three categories--the operating system, authoring software, and application program. The application programs represent the content and logic of the interactive television program. The authoring software provides the means for entering these programs, while the operating system provides the mechanism for the delivery of the interactive television programs to the system's users.

The objective of Phase I is to enhance the existing operating system developed in MITRE's CAI program. The authoring software will also use programs developed in this project. In addition, a translator program will be used to convert the selected elementary school level CAI programs into the form accepted by the existing authoring software. The need for new application programs will be minimized by the use of available CAI programs.

APPENDIX

ORGANIZATIONS AND INSTITUTIONS REPRESENTED BY VISITORS TO THE MITRE CORPORATION'S TICCIT DEMONSTRATIONS

FEDERAL GOVERNMENT

Central Intelligence Agency
Corporation for Public Broadcasting
Department of Commerce
Department of Defense
Department of Health, Education and Welfare
Department of Housing and Urban Development
Department of the Interior
Department of Justice
Department of State/Agency for International Development
House Commerce Committee/Subcommittee on Communications and Power
Internal Revenue Service
National Academy of Engineering
National Aeronautics and Space Administration
National Bureau of Standards
National Science Foundation
National Security Agency
Office of Economic Opportunity
Office of Science and Technology
Office of Telecommunications Policy
Peace Corps
Smithsonian Institute
U.S. Information Agency/Voice of America
U.S. Postal Service
Veterans Administration

EDUCATIONAL INSTITUTIONS

American University
Antioch College, Baltimore, Maryland
Board of Regents – Atlanta School System
Brigham Young University
CAI Laboratory, University of Texas
Catholic University
Columbia University
Drexel University
Educational Satellite Center
Einstein High School
Essex County College

EDUCATIONAL INSTITUTIONS (continued)

Fairfax County Public Schools
Federal City College
Howard University
Hunter College
Johns Hopkins University
Massachusetts Institute of Technology
Montgomery College
New York University
Northern Illinois University
Northern Virginia Community College
Penn State University
Pine Ridge Elementary School
State Department of Education Richmond
University of Maryland
University of Virginia
Virginia Computer College

COMMUNICATIONS INDUSTRY

AMP, Incorporated, Harrisburg, Pennsylvania
Bell Laboratory
Burroughs Corporation
CBS Laboratory
CBS-TV
CCA Electronics
COMSAT
Continental Telephone
Cypress Communications
DATRAN
Electronic Communications, Inc.
FEC Electronics
General Electric Company
GTE Laboratories, Waltham, Massachusetts
Hazeltine Research, Inc.
Holmes Protection, Inc.
Honeywell
IBM
IEEE

COMMUNICATIONS INDUSTRY (continued)

Industrial Technological Interface, Inc.
Informatics, Inc.
Jerrold Electronics
Jersey Enterprises
Lockheed
Maryland Center for Public Broadcasting
Metropolitan Mass Media
National Association of Broadcasters
National Audio Visual Corporation
National Cable Television Association
Page Communications
Philco-Ford
Raytheon
RCA, New York
Sperry Rand Corporation, New York
Sylvania GTE
TELCOM
Texas Instruments
Video Engineering
Western Union
WGBH-TV – Boston
WNVT-TV – Arlington
XEROX Corporation

INTERNATIONAL

BELL Canada
Canadian Radio and TV Commission
Gallo Fillio, Rio de Janeiro
Gama Fillio University, Brazil
Government of Guatemala
Hitachi, Ltd., Japan
ICS Consul, Paris
Millim Company, São Paulo
ORT Computer Center, Buenos Aires
Partaw Electronics, Teheran
Teijin, Ltd., Japan
Univ. Federal de Rio de Janeiro
Volvo, Sweden

MUNICIPAL, FINANCIAL AND CITIZENS GROUPS

American Banking Association
Arlington CATV Association
Citizens for Arlington TV
Columbia Hospital System
D.C. Department of Human Resources
D.C. Library
International City Management Association
Management Advisory Council of Northern Virginia
Mayor's Economic Development Committee – D.C.
Mayor of Madison, Wisconsin
Metropolitan Regional Council of Governments – D.C. metro area
Opportunity Funding Corporation
World Bank

MEDIA REPRESENTATIVES

Arlington County Performing Arts
Children's Television Workshop
DATAMATION Magazine
Educational Information Services
McGraw-Hill – Continuing Education Company
National Geographic
Popular Science Magazine
Readers Digest
Standard and Poors Investment Capital, New York
Washington Star

FOUNDATIONS AND RESEARCH INSTITUTIONS

Aerospace Corporation
American Library Association
Arthur D. Little Company
Cafritz Foundation
CATV Information Center
Ford Foundation
Hudson Institute

FOUNDATIONS AND RESEARCH INSTITUTIONS (continued)

Human Sciences Research
Imagination Foundation
International Research and Technology
Kettering Foundation
Kiplinger Foundation
Lincoln Laboratories
Markle Foundation
Myer Foundation
RAND Corporation
Research Analysis Corporation
Sloan Commission
Urban Institute