TWO-WAY TV TELECONFERENCING FOR GOVERNMENT: THE MRC-TV SYSTEM

PREPARED FOR THE METROPOLITAN REGIONAL COUNCIL UNDER A GRANT TO THE COUNCIL FROM THE NATIONAL SCIENCE FOUNDATION

RUDY BRETZ
WITH A CONTRIBUTION BY LAURENCE A. DOUGHERTY

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The Metropolitan Regional Council (MRC) is a voluntary association of chief elected officials in the New York-New Jersey-Connecticut metropolitan region. MRC has constructed a telecommunication system (MRC-TV) that will enable government officials in the three-state region to communicate with one another quickly and efficiently. The system employs a two-way microwave television system with main studios at MRC headquarters in the World Trade Center in Manhattan and nine primary stations in county seats and other selected cities throughout the region. Eventually, there will also be smaller studios at governmental centers within each county. Initially, the smaller studios will have one-way video and two-way audio capabilities.

Because MRC-TV is the first intergovernmental teleconferencing system, it is a potentially important social experiment. This report traces the history of the project from 1969 to January 1974, from inception through its planning and early operational phases. Intended as a guide for planners of similar systems, it assesses MRC-TV's operating experience in terms of system design, program content and format, and other behavioral and technological factors.

Early in planning the MRC-TV system it became apparent that an experimental evaluation would be highly desirable. These efforts would include analyzing the present pattern of intergovernmental communications as a base case, measuring changes that take place in the existing pattern because of the MRC-TV system, and, on the basis of this experience, exploring the potential future role of similar systems elsewhere.

The National Science Foundation provided MRC with funds to evaluate this potentially important governmental innovation. The Rand Corporation contracted with MRC to develop the evaluation methodology, to evaluate the system's impacts, and to provide guidance during the development and early operation of MRC-TV. Rand's participation comprises three phases.

Phase II, the subject of this report, involves monitoring the MRC-TV system in its early use in order to identify problems and opportunities; to suggest how problems can be solved and opportunities exploited; and, more generally, to recommend how system effectiveness can be enhanced through experiments with new services, training of government personnel in these services, and modifications both in system design and in equipment usage. Phase II also includes continuing analysis of the baseline survey data from Phase I in order to delineate key hypotheses regarding the nature of communications flows among government officials in the metropolitan region and to refine the survey techniques that will be applied during Phase III. The results of this portion of Phase II will be treated in a forthcoming Rand report.

Phase III will involve analysis and measurement of major changes in intergovernmental interaction brought about by the system, tests of hypotheses formulated in the base-case analysis of Phase I, and cost-effectiveness studies of services developed by the system during Phase II.

The present report is intended for several audiences involved at various phases in the design and operation of a two-way TV teleconferencing system: (1) the administrator -- government, corporate, medical, or educational -- who must decide whether or not to invest in a system similar to MRC's; (2) the system designer or builder who must design a system and wishes to know which features of MRC-TV were successful and which needed to be changed or caused problems; (3) those who actually use an operating system of this type and who need to know
what staff training is necessary, and what techniques will help to
make the system most effective; (4) the educator or trainer, who may
have the opportunity to use a two-way television system in instruction
and for whom MRC's experience in interactive teaching will be of vital
significance; and (5) the communications scholar or behavioral
researcher who may use some of the experiences and insights recounted
here to indicate fruitful and important directions for research.
SUMMARY

The Metropolitan Regional Council (MRC), an organization of governments covering the greater New York metropolitan area, devotes its major efforts to the encouragement and improvement of interaction between local governments. With transportation becoming more difficult and time-consuming, and energy at a premium, MRC chose to pursue its goals through the use of intercommunication. This is a report on the planning, development, and operation of the two-way television system that MRC is now using. The emphasis throughout this report is on what others in government or other institutions may learn from the MRC experience.

The MRC-TV system is not the first use of television to join together two widely separated groups for a single meeting. It is the first, however, to join as many as ten together at once. It is not the first TV system to be called interactive; but it is the first to join so many locations in a two-way (symmetrical) system: audio and video to and from each site. This unique capability, allowing people to both see and hear each other in a natural conference relationship, appears particularly well suited to the communication needs of government officials. The motion video component allows for a degree of interpersonal rapport similar to face-to-face interaction. When used for instructional purposes, the two-way feature encourages an interaction between teacher and learner that is highly prized but not always achieved in face-to-face classroom teaching.

The "program content" of MRC-TV bears little resemblance to conventional television services; the written script, the rehearsed and formally presented program are all but unknown. MRC-TV content consists largely of conferences, meetings, and seminars, whose planning and development are probably similar to what goes into conventional face-to-face conferences. Twenty-five meeting groups of functional counterparts, such as a group composed of personnel directors, and another composed of purchasing agents, have been organized and have used MRC-TV on a regular basis to discuss common problems. In addition, regular in-service training courses for county personnel have been instituted. MRC-TV has offered
Supervision and Management, Effective Writing for Administrators, ABC shorthand, Telephone Communications, and the Management of Time Workshop. And others are being planned.

The preplanning, planning, and development of the MRC-TV system covered a period of about four and a half years, from early 1969 to late 1973. From the signing of the equipment contract to the start of regular operation, two years elapsed. Because of a serious shortage in funding, the equipment was acquired on a ten-year lease basis. Most of the MRC-TV planning was supported by MRC itself, out of its regular dues income from subscribing governments. Operation of the system is being partially supported by an additional $14,000 a year from each of the member governments that elected to participate in the television system. After an initial grant of $50,000 from HUD for a feasibility study, grant monies were very limited and generally earmarked for specific purposes, such as special seminar series, in-service training courses, and, in the case of a three-phase NSF grant, for evaluation and monitoring of the system by the Rand Corporation.

Generally, the MRC-TV system has 20 to 30 hours a week of regular use. Its physical operation requires a basic staff of one communication director at the World Trade Center headquarters and one maintenance technician for the entire system, plus part-time county-employed operators at each outlying location. One MRC staff member is responsible for all instructional courses. The equivalent of four staff members plans meetings, each staff member preparing two to four specials or intergovernmental meetings per month.

So far, the average number of county locations participating in the regular intergovernmental meetings has been six; the average number of participants at each location, two. Attendance at special seminars and in-service training courses is often 10 to 20 at each site.

The system itself consists of one microwave transmitter, allowed only 10 watts of power, with omni directional antennas on top of the One World Trade Center (WTC) building. Each county responds via its own microwave beam. A small studio and a switching center for the system are located in the WTC building. Each county studio generally is a converted conference room and is provided with a remotely controlled
camera and two monitors, plus a small control console so a local operator can control the local camera, audio and transmitter facilities. A future service is already provided for: each local site is equipped with a small omnidirectional antenna with which to reach future "one-way sites" equipped for reception only, in the immediate county vicinity.

Transmission to and reception from the WTC central point requires the use of parabolic reflectors ten feet in diameter at most sites; these had been inadequately installed and constituted a prime source of trouble during the first few months of operation, especially after periods of high wind. The electronic equipment gave many fewer problems than had been anticipated; no camera problems arose, and audio problems were minor.

Several basic changes had to be made in the system design, luckily inexpensively, to adapt its operational procedure to the needs of normal meeting behavior. Means were devised so a chairman in the WTC studio could preview county groups before calling on them in a meeting. A major problem was posed by the design feature that always required audio to be switched in synchrony with the video. On Rand recommendation the audio was made open so the chairman could converse with a county site that was being previewed, or could verbally interrupt a participant who was on the line. The ability of two conversants to both speak at once is an important characteristic of normal human interaction; system designers had not recognized this fact. Finally, adaptations were made to the system used by county participants to signal their desire to speak.

Several problems remain unsolved at this writing. Should partial or total system failure occur, there is no audio backup system such as special audio lines or means of resorting to the outside phone. About half the counties still do not have outside phones at their control consoles. This makes split-screen effects, essential to the MRC-TV system, difficult to effect quickly and easily, and prevents the central controller from helping a county operator during a program if he experiences difficulty in sending out a good picture. Eventually means will be provided for the chairman in the WTC studio to do the program previewing
and switching directly rather than to have to coordinate this with the WTC controller. A relatively minor problem, in the opinion of most observers, is that the use of visual materials, especially at the county studios, has been rudimentary or nonexistent.

In the final section on system costs the investment cost was estimated at $760,000, almost three-quarters of which was related to the equipment, covered on a ten-year lease. Annual costs for operating the system at its current operating load are estimated at $274,000. Estimates for 5-site and 15-site systems are also projected from these figures. Although a comparison with the costs of face-to-face meetings was not part of this study, a rough comparison suggests that when the value of people's time is taken into account, the MRC-TV cost per meeting, even at today's relatively low level of programming, compares closely with the travel alternative.

Despite the fact that visual information, such as graphic materials, maps, charts, photographs and the like, have played a minor role in MRC-TV meetings, many observers felt that the use of full two-way video is justified by the added contact and increased rapport that it appears to generate between participants. These judgments are made in relation to telephone interaction on the one hand, and face-to-face meetings on the other, since these are generally the only two interactive methods with which most people have had experience.

The system appears to be enthusiastically accepted by most of its users; it is doing what it was intended to do; it is clearly resulting in a large amount of local government interaction that was not going on before; and it is bringing interactive training in many subject areas to county and municipal employees who did not have in-service training opportunities before.

A formal evaluation of the system's effects including cost/benefit analysis, especially in relation to travel alternatives and MRC-TV's impact on communications flows among member governments, is to be part of the subsequent Phase III effort proposed by Rand.
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I. INTRODUCTION

ORIGINS OF THE PROJECT

The Metropolitan Regional Council, which has been in existence for 17 years, serves one of the largest metropolitan areas in the world (Fig. 1). The 10,000-square-mile area includes parts of three different states (New York, New Jersey, and Connecticut), 22 counties, and 550 general purpose governments (cities, villages, towns, townships, and boroughs). This urban area includes a total population of 19 million people, almost one-tenth of the nation.

MRC's primary aim, like that of the over 100 other councils of government in metropolitan areas throughout the country, is to foster cooperation and coordination among agencies and governmental units. MRC viewed itself as facing the following challenge:

A communications gap exists in the region due primarily to the time consumed in traveling to a central location for a meeting and also due to the busy schedule faced by a chief elected official each day in his own home area.

As a result, elected officials have not yet developed a true regional concern and regional outlook. Instead, consideration for solving a problem involves only what is good for the local community and not what is best for the region as a whole. Similarly, communication between local officials from neighboring communities has been severely limited. Yet, it has become clear to all that the problems of air and water pollution, transportation and education can only be solved through joint action by the several municipalities and states of the region.

To solve its communication problems, MRC began considering a television system in 1969. HUD felt that the idea might have merit and granted MRC $50,000 to conduct a feasibility study to determine whether the idea was possible, if the means were available, and what the costs might be. Such a system was possible. With its first experimental program in July 1973, MRC-TV became a reality.
Fig. 1 — The Tri-State Metropolitan Area
MRC-TV

MRC-TV is a 2-way black and white television system, one of the most extensive and complex teleconferencing systems yet developed, providing two-way audio-visual interaction among government officials at a central facility and nine outlying locations. While interactive conferencing between more than two locations in a single meeting has been possible in some other systems, such as the Omaha Veterans Hospital system, the Dartmouth Medical School INTERACT system, the Massachusetts General Hospital Telemedicine system, and the British Post Office Confravision Service, it has been the exception rather than the rule, and has rarely exceeded three locations in any one meeting. At this writing, well over one hundred intergovernmental meetings and training sessions have been held, practically all of which have involved the interaction of three or more locations (the average number of locations participating at one time has been six).

Using low-power microwave transmitters with omnidirectional and beam antennas, MRC-TV links a studio and control center in the World Trade Center building in downtown Manhattan with nine local governments in the vicinity of New York City (Fig. 2). Eventually, the system should include 17 county locations, each equipped to reach "one-way sites" in their near vicinities.

One main transmitter in the central facility broadcasts omni-directionally (sending radiations in all directions) to the county facilities via two pylon antennas from the roof of the World Trade Center. Because the transmitter operates at low power in comparison with standard broadcasting, receiving sites must be equipped with relatively large parabolic (dish) antennas of up to 10 feet in diameter. The most distant two-way sites, Stamford, Connecticut, and New Brunswick in Middlesex county, New Jersey, are 36 and 27 miles distant, respectively. When the system reaches its anticipated 17-county capacity, some sites will be almost 50 miles from the central point. Sites that are not in direct line of site from the World Trade Center require intermediate relay points.

*Seven of these are county governments and two are municipalities. For simplicity, this report refers to them all by the term "counties."
Fig. 2 — MRC-TV interactive microwave television network
The county facilities can also originate and transmit programs. A small conference room at each participating county's headquarters is equipped with a single camera and associated studio equipment. Picture and sound can be transmitted directly back to receiving antennas on the roof of the World Trade Center by microwave beam. That county signal can then be retransmitted to the other participating sites. At a third level, the county centers can also transmit to their own localities. Each center is equipped with a low-power omidirectional antenna to enable it to transmit to one-way sites -- branch offices and other governmental centers such as borough and village halls, fire stations, police stations, hospitals, and neighborhood community centers. These sublocations will be equipped with only one-way video. Audio feedback, at least to the local county center, will be possible through the regular telephone system or through private phone lines.

At present, only one sublocation has been activated. The use of the local omidirectional broadcast capability is expected to grow, according to local option, as the usefulness of the basic New York City-centered system becomes established. MRC is seeking support for demonstration projects to encourage the use of communication strictly in local areas, including uses that are unrelated to the central system.

Unlike previous applications of television, MRC-TV program content consists largely of meetings, organized and implemented much as ordinary face-to-face meetings are. The previously prepared and rehearsed program is nearly unknown, although speeches and talks, both formal and informal, are frequent. Even when the system is used for training purposes, instructors make the most of the interactive possibility, teaching by class discussion and socratic methods rather than by the usual one-way presentation or lecture method characteristics of most instructional television.

THE BASE STUDY: A REVIEW (PHASE I)

The first phase of Rand's evaluation procedure began in June 1971
and was completed by the end of March 1972, more than a year before MRC-TV operation began. It developed an evaluation methodology and gathered baseline information on the nature of intergovernmental communication. The information will be usable both for later evaluation of the MRC-TV system's impacts and also as a first step in understanding intergovernmental communication in a metropolitan context -- a vastly understudied subject in American government.

Rand mailed a questionnaire to 1200 public officials in the metropolitan region; 648 of these people, or 54 percent, responded in time to be included in the analysis. The questionnaire contained 158 questions on the nature of the respondent's work, background, and attitudes, plus basic data on his office or department.** Attitudes toward innovation, continuing education, and cooperation with other governments were also assessed. An extensive section sought data on present habits and procedures of communication with people in other units of government, as well as on the information and communication modes that were used.

The major findings of this study revealed the conditions of intergovernmental communication in this area (as they existed in the last half of 1971) in such matters as communication mechanisms, communication patterns, and obstacles to communication. Three major intergovernmental communication mechanisms were identified: (1) peer groups -- informal groups of functional counterparts existing mostly within county boundaries; (2) formal intergovernmental channels; and (3) professional organizations and governmental associations.

The major patterns of communication revealed by the study showed that governments having the most intercommunication tend to be those

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**Nearly half of these were combined into multiple-part questions, so the total of numbered questions was only 81.
that (1) are adjacent to each other and have problems to settle at their common boundaries, (2) are close enough together to have problems in common within their individual jurisdictions, and (3) cover sufficiently similar communities that they share problems, even though they may be far apart geographically. A fourth pattern involves contact between officials of different governments that share the same areas of specialization (peer groups). Most intergovernmental communication seemed to be concerned with technical or engineering matters; there is little communication and less action on the pressing social issues in the region such as poverty, housing, and racial integration.

The primary obstacles to intergovernmental communication were interpersonal in nature. The most common reasons given for not contacting other governments was that the respondent did not know whom to contact, and, when contact was made, felt that the officials in other governments often did not seem responsive. The obstacles of time and distance were considered important to almost half of the respondents to the questionnaire, but very important to only one out of six. Over 40 percent of the respondents, however, complained that it is difficult to resolve issues via the telephone, and the mails are too slow.

The report on Phase I evaluation was carefully studied and used in part to guide the planning and operation of the MRC-TV system. For instance, MRC developed 25 intergovernmental peer groups, which immediately extended the peer-group mechanism across county lines. By the end of January, 59 intercounty peer-group meetings had been held via MRC-TV with an average of about six counties participating in each meeting. MRC-TV meetings of local government officials with such organizations as the Tri-State Regional Planning Commission, the New York State Office of Planning Services, New York Highway Commission, and a review of the A-95 project conveyed the kind of governmental information usually attained through the mechanism of professional organizations and governmental associations.

**MONITORING AND CONSULTING (PHASE II)**

The second phase of Rand's work began in June of 1972. At this point the MRC-TV system had already been designed, equipment had been
constructed and was being delivered. Since the MRC staff was not familiar with the details of the system when it was being installed, or with its many potential applications, the first task for Rand was to analyze the system design and interpret it to the MRC staff in terms of human use.

The shortcomings that were detected in system design are discussed subsequently in this report. Monitoring visits of a week each were made to the system every 2-1/2 months during the first year, and every month, on the average, after the system became operational. After each visit a memorandum or a working note was forwarded to MRC containing a report on observations, with recommendations for improvement. In addition to the present summary report, a total of some 25 communications of various kinds were generated by Rand during Phase II. Fourteen of these were letters or memorandums and eleven were documents. Also during this period, Rand continued to study other interactive communication systems both in the United States and abroad. Rand staff visited research groups studying the human variables or the social implications of interactive communication and collected data on some fifteen past or present operating systems. Twelve systems were visited, plus six research organizations involved in studying interactive telecommunication.

**ORGANIZATION OF THIS REPORT**

Those who may be considering interactive telecommunication, but who may be unfamiliar with its basic modes, will want to examine Sec. II, which describes the various classes of TV teleconference systems. Other readers may wish to go directly to Sec. III, which gives the history of the preplanning and planning stages of the MRC-TV system. Section IV contains descriptions of programming practices, a typical MRC-TV schedule, and a discussion of special types of programs. Then Sec. V describes the system's development and early operation, including descriptions of problems that arose and how they were handled. Section VI describes the adaptations that were made to the system after it was installed. Section VII presents a nontechnical
description of system costs, and develops a cost model for planning purposes. Four short appendices support the text: Appendix A lists the most important recommendations made by Rand; Appendix B is a fact sheet that was distributed at an early date to local governments participating in MRC-TV; Appendix C is a typical meeting notice distributed by MRC to persons who might be interested in participating; and Appendix D lists MRC-TV component parts and numbers.
II. MRC-TV, OTHER TELECOMMUNICATION SYSTEMS, AND THE FIELD OF TELECONFERENCING: A PERSPECTIVE

Readers who are exploring the teleconferencing field for the first time hoping to find ways to improve their communications will want to learn about a number of classes of interactive telecommunication systems to decide whether any might suit their needs. This section describes four classes of two-way TV teleconferencing systems, and puts the MRC-TV system into perspective among them. Of the four, the MRC-TV system represents the most complex class.

Before describing these systems, it should be helpful to define what interactive telecommunication and teleconferencing are, and in doing this one must also define what they are not.

INTERACTIVE TELECOMMUNICATION AND TELECONFERENCING

The prefix tele is from the Greek, meaning distant, and can be applied to any communication or conferencing medium that can electronically transmit a message so that it may be received simultaneously (or nearly so) with its origination. Interactive telecommunication requires that messages be transmitted and received in both directions between two or more communicating parties. Most interactive telecommunication is person-to-person, like the telephone. "Teleconferencing," however, applies to interactive communication in which groups of two or more persons at a given location are involved, or single individuals at three or more locations. (Two kinds of groupings are distinguished in the pages that follow: two or more people at a single location are called a group; and groups or individuals at more than one location, in the aggregate, are called a system-wide group.)

There are some familiar kinds of interaction via the media that are not really interactive telecommunication, because they do not involve most listeners as participants. Also, as we have already said, person-to-person interaction is not teleconferencing. These kinds of communication are
discussed first, after which a classification system for two-way TV systems is described.

*Audience-Participation Programming on Broadcasting Channels Is Not Interactive Telecommunication*

Television broadcasters have long presented programs that incorporate response from people in the audience, either the studio audience, in which case the responders are both seen and heard, or the home audience, in which case they are only heard. A staple of radio broadcasting today is the telephone "phone-in" program. But radio and television are mass media. The handful of persons who participate in phone-in programs is miniscule compared with the audience of passive viewers. For the actual participants the program can be interactive communication in the fullest sense. For the other 99.99 percent or more, the thing is only a program on one-way television or radio and the few participants are part of the show.

*Audience-Participation Programming on Public Access Cable TV May Be Interactive Telecommunication*

Local people who participate in or produce their own community programming on public access cable TV channels often feel that they are "on television," and when they incorporate phone-in response, that they are doing audience participation programming. They interpret "public access" to mean access to the public. In fact, however, the public access channels on cable TV systems are not heavily watched. The cable television public access channel, unlike the entertainment channels, is really not a mass medium. Public access really means access by the public, to the medium, as the FCC originally intended when the requirement was formed.

Thus the handful of persons calling in or talking with the callers in a cable TV public access studio may represent the entire audience of persons who are watching the program. While the producers of the program may not know it, they may not be doing audience participation television at all, but are really engaging purely in interactive communication. This does not imply that such a use is limited or inappropriate. It may be one
of the most important services that cable TV, with its multiple channels, can provide to the community. There are helping organizations, such as the Alternate Media Center in New York that understand the role public access channels can play. Such organizations do their best to encourage community people to look for intercommunication needs within or between local institutions and organizations and to start using the public access channels for these purposes.

Person-to-Person Interaction Is Not Teleconferencing

Most interactive telecommunication today is person-to-person, that is, a double channel transmitting in both directions with a single send and receive terminal at each end. The prime example is the telephone. It is not called a mass medium, even though there are millions of phones; it is a one-to-one or person-to-person system. It is properly called "two-way," since the pair of lines connecting telephones, each with a microphone on one end and a speaker on the other, permit communication to flow in two directions.

An exception perhaps, or a transitional case, is the party line, which may be closed-circuit, person-to-person intercommunication for two people, while providing one-way entertainment for many others. The use of transceiver radios for communication between sheep stations in the Australian outback is an example of party-line radio. Everyone knows everyone else's business over an area of thousands of square miles.

Telautograph is another example of interactive telecommunication, a system that usually conveys only handwriting, although it can be combined with a voice system as well as in telewriting. Still-picture television is also used for person-to-person interaction. Facsimile may be used, combined with the telephone for conversation. This is not very immediate, however, since when regular phone lines are used a good quality picture can take 2 or 3 minutes to transmit. The medium with the greatest capability, of course, is television. Person-to-person systems utilize the commercial videophone equipment, or assemble two-way, closed-circuit television systems with single-person terminals.
Teleconferencing Between Isolated Individuals

Computer conferencing is presently accomplished via a wide spectrum of media including alphameric (letters, numbers, and other symbols), graphic displays, and voice to name a few. The FORUM system, for instance, uses the alphabetic keyboard, and colleagues widely separated in space can carry on a meeting with a sort of back-and-forth correspondence, similar physically to man-computer interaction. FORUM is intermediate in nature between live (real time) interaction, for which telemedia are needed, and the delayed interaction of correspondence by mail. A FORUM conference may cover days or even weeks, since each participant may enter the meeting or leave it at his own convenience. The computer manages the meeting, keeping track of which participants have received which entries, conveying messages only to specific persons when addressed to do so, and distributing anonymous messages when someone wishes to be very blunt. This medium can thus add features or dimensions that do not exist in conventional face-to-face conferencing. Any uses of the computer in teleconferencing, however, with the present state of the art, involve very high computer and software costs.

The telephone is sometimes used in the conference-call mode so that three or more persons, each at different places, can all talk and hear each other at once. These phone company services are apparently satisfactory when people know each other and can recognize each other’s voices, but many parts of the country still require the assistance of an operator; but even where they do not, for reasons that have not been definitely determined, they are rarely used even by phone company administrative personnel. With the audio-only medium, when more than two locations are interacting, all may be open at once so that anyone may be heard at any time. An analogous open video is not possible unless multiscreen terminals are to be used, and sufficient circuits are available to connect each terminal with every other terminal. Since video circuits are expensive, this is generally impractical; multilocational video teleconferencing of isolated viewers would require a switched system and has not been offered as a video telephone service.
Teleconferencing in the Group Mode

A telephone conference call may also be no more than a standard two-location connection converted to the group mode of use. The terminal equipment may consist only of a loudspeaker, in which case the group may all hear, but only one person at a time, using a hand set, may reply; or it may consist of a speaker-microphone combination that allows any member of the group to be heard. This is also frequently called a conference call, but it should be distinguished from the multilocalational conference call, perhaps by naming it the group mode conference call. This group mode conference call is used more commonly, but while convenient to the group, is often most uncomfortable for a respondent on the other end, who can never be sure who is listening. Strangely, videophone users have not reported this uneasiness, even though unidentified persons may be listening outside of camera range.

Video telephone is currently being utilized in a group mode configuration, beyond the simple expedient of having two or three people use a single video phone terminal. The terminal is basically a small camera-monitor combination that stands about 12 inches high and can be placed on a table or desk before the user. Bell Telephone Labs has developed a voice-actuated switching system for use when there is a small group together at a single location. Each participant has his own individual Picturephone terminal, and when a person speaks, his camera is automatically switched onto the line. Long-distance two-location conference calls can be made (Chicago-New York, Chicago-Washington, and New York-Washington) using this equipment configuration, but the participants must gather at a single phone company facility in each city.

THE CLASSIFICATION OF TELECONFERENCING SYSTEMS

Teleconferencing systems can be classified in several ways. A simple manner is to class them according to the fields in which they are used: for example, medical systems, educational systems, government systems, and industrial systems.

Probably the most insightful way to classify teleconferencing is according to the purposes for which the parent institution uses the system.
This method produces four categories at present; there is no certainty that these are exhaustive however, and further uses may well be found in the future.

1. *Intracommunication.* An institution seeks to improve internal communication within a plant or between plants. Probably the earliest teleconferencing systems were constructed by New York banks to interconnect a conference room in a downtown headquarters with one in an uptown branch. Another example of internal communication is the recent Boeing Teleservices system that enables large groups of people at various plants and military headquarters around the country to participate in conferences, briefings, design reviews, and the like. The telemedia utilized in this case are audio and facsimile, both transmitted by wire. In addition, projectuals are distributed to all participating groups in advance, or prepared quickly during conferences from transmitted hard copy. Therefore, it could be called a multimedia system.

2. *Extension.* An institution seeks to strengthen itself by extending its services into the community. Examples of such systems are the essentially closed-circuit ITFS systems (Instructional Television Fixed Service) built by universities (i.e., Florida, Stanford, Southern California, etc.) to provide graduate engineering courses to engineers at the industrial plants where they work. Major hospitals, like Massachusetts General, have built two-way, two-locational, individual and group mode systems for telediagnosis, teleconsultation, and other applications of telemedicine. Using these systems, patients in outlying clinics and medical stations, for example, may be examined by physicians who cannot leave the main hospital.

3. *Common carrier.* The institution is a common carrier seeking to provide an additional service. This is essentially a public utility function. The telephone company has provided a regular commercial picturephone service to private offices in Chicago, and in Pittsburgh and Washington on a custom basis, as well as
long-distance service already described. In Britain, one of the Post Office services is a system the British call "Confravision." Canada and Australia have built similar systems. Television-equipped conference rooms are provided in five British cities, for instance; groups meeting in any two of these locations may see and hear each other in a teleconference. To offer the service to people who wish to use it for internal communication between offices of a single institution, Confravision is designed to be private. The participants themselves may operate it and no operating personnel are required, either in studio or control room.

4. An inter-institutional organization seeking to provide better coordination and exchange of information between its member institutions. A common example of this category is the consortium of colleges and universities, such as TAGER in Texas, that operates a closed-circuit system to interchange courses by instructional TV. Audio systems are generally used for response in such cases. MRC-TV is believed to be the first government system of this category.

Still another way to subdivide the field of teleconferencing systems is to classify them according to the media technology that they use; e.g., audio systems, still video systems, television systems, and the like. Taking this approach we run into trouble, however, in classifying systems that are unsymmetrical, i.e., one medium is used for communication in one direction while another medium is used for the return path. In this report the term "two-way" is used to refer to a system that is symmetrical in terms of media. Because the MRC-TV system is a symmetrical television system, our particular interest will be to distinguish it from other two-way television systems that have different characteristics and modes of use.

The term "interactive television," is avoided here because it has been used loosely to apply to unsymmetrical systems in which response is communicated by lesser media such as audio, or merely by digital pulses. In choosing instead the term "two-way," we risk an ambiguity: the reader may think we mean a system connecting only two terminals or locations. In our own use of the term, however, two-way can apply to systems with
multiple locations; it will mean simply a symmetrical income and output at each location.

It would seem that by narrowing our interest in teleconferencing to systems that use the television medium, and further, to only those that use it in the two-way mode, we have greatly simplified the task of classifying the systems that remain. There are, however, at least three more levels at which different kinds of two-way television systems may be distinguished, according to characteristics that make a basic difference in how the system is designed, what it may cost, and how it can be used.

Two-Locational Systems

The earliest two-way television systems were two-locational. For example, several New York City banks installed two-way television between conference rooms in their downtown headquarters and in their midtown branches. For nine years the State of Nebraska operated a two-way television system between the University of Nebraska Medical Center in Omaha and the Norfolk State Hospital 112 miles to the north.

Multilocational Systems

It was a simple next step to install a switching center somewhere in a two-locational system so that a third location might be substituted for one of the first two. In Nebraska, the Omaha system grew to include over six locations reaching west to Lincoln and Grand Island, Nebraska. Massachusetts General Hospital was tied in with the medical station of Logan Airport, and later with the Bedford Veterans Administration hospital in the Boston suburbs. A system was built by Dartmouth Medical School serving seven locations in New Hampshire and Vermont. The British Conferencevision system, previously described, can interconnect any two of five British cities via two-way TV.

Any of these systems can interconnect two points at a time. Such systems resemble the video telephone, except that they are designed for use in the group mode. Joining three or more locations for a single teleconference is far less common. It may be possible in many systems, and
at many it may have been done experimentally or as a demonstration, but regular operation in which practically all system uses involve three or more sites is a new development in the field (at MRC-TV the average number of sites participating in a teleconference is six).

Multilocalional two-way TV systems that can include three or more locations in a single teleconference must still be subdivided in one more important way. This distinction is between switched and unswitched systems, i.e., systems that interconnect all points simultaneously, and those that interconnect in a sequential manner. In an unswitched system all locations are in constant interconnection — audio is open among all sites so everyone may speak at any time and be heard, and each site is simultaneously seen at every other site, on separate monitors. If there are more than three or four sites, many monitors and much space is required at each. Even more important, transmission costs are high because each site must have a line to every other. A system design by the Australian Post Office Research Labs reduced this by essentially transmitting two sites at a time in split screen.* Even so, a system of only five locations would require three or four TV channels to and from each location. At present the unswitched TV teleconference system exists in theory only; we are not aware of any operating systems of this nature. It is important that we describe this category, however, because it is usually a system of this type that the average layman imagines by the term multilocalional. The MRC-TV System, as well as all other operating multilocalional two-way TV systems is a switched system.

SUMMARY

The classification of TV teleconferencing systems discussed above is summarized in Table 1. This table, the reader is reminded, considers only two-way (symmetrical) systems, and only systems that utilize two-way television. With other media, the classification will have to be different. The table shows how two-way TV teleconferencing systems are divided into

Table 1

TWO-WAY TV TELECONFERENCING SYSTEMS

<table>
<thead>
<tr>
<th>Number of Locations in System</th>
<th>Primary Operational Mode</th>
<th>Inter-Connection</th>
<th>Examples</th>
<th>Class</th>
</tr>
</thead>
<tbody>
<tr>
<td>Two-locational (only 2 sites in the system)</td>
<td>2 at a time</td>
<td>Unswitched (open)</td>
<td>Bank systems</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>2 at a time</td>
<td>Unswitched (open)</td>
<td>Confrervation</td>
<td>2</td>
</tr>
<tr>
<td>Multi-locational (3 or more sites)</td>
<td>3 or more at a time in a single conference</td>
<td>Unswitched (open)</td>
<td>Some designs by Australian Post Office Research Labs</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Switched</td>
<td>MRC-TV</td>
<td>4</td>
</tr>
</tbody>
</table>

two-locational and multilocalional, how the latter is divided into two again on the basis of the number of sites that participate in a single conference, and how the latter of these is again subdivided into switched and unswitched systems. MRC-TV is an example of the last of these: the switched, three-or-more-locations-at-a-time, multilocalional system. Four classes of two-way TV teleconferencing systems are defined in this simple taxonomy, and arbitrarily numbered from one to four.
III. PREPLANNING, PLANNING, AND DEVELOPMENT

PREPLANNING

With HUD's $50,000 grant in 1969, the MRC-TV project entered its preplanning phase, involving exploration of the feasibility of an intergovernmental closed-circuit TV system. First, MRC contacted the telephone companies to investigate the cost of using telephone lines for audio and video transmission between New York City and the outlying local governments. Finding that use of the telephone companies as a common carrier would be financially infeasible, MRC turned to the possibility of a private microwave system as the best alternative. After consulting with the FCC and contacting various organizations that were already actively operating microwave systems for instructional purposes, MRC retained a consulting engineer to search the spectrum allocations for the New York area to determine the availability of frequencies for intergovernmental use.

As a result of the consultant's study, MRC applied to the FCC for transmitter licenses at the World Trade Center and 17 outlying locations. The best possibilities were in the ITFS band.* Although the 31 microwave channels in this band had been available for almost ten years, some remained unassigned in the New York area in the particular local areas and directions of beam propagation that MRC required. Furthermore, the FCC had recently removed three of these channels -- H1, H2, and H3 -- from the ITFS designation. In September of 1970 the FCC assigned four channels to the 18 transmitters; one for the World Trade Center main transmitter, and three for return channels from the county sites. (A fifth was added for Mineola, Nassau county, to avoid interference with existing services.) The system had to be designed so that as many as three county sites could share a single response frequency.

*The channels in this band had been reserved for instructional and other fixed-point (non-mobile) services.
Finding a System Builder

As the next step, contractors were encouraged to submit bids on the construction of the microwave system. The response, however, was disappointing. (This has been interpreted as a natural reluctance of industry to become involved in something so essentially new that its problems and pitfalls were unknown.) TelePrompTer and Varian submitted bids, but these were largely for equipment components, leaving it up to MRC to design and construct an operating system. The source of investment capital was also a nagging concern.

The solution was found in the offer of the Genesys Corporation of Palo Alto, California. Not only did Genesys undertake the design and installation of the system, but also offered to assist MRC with the necessary "front-end money" -- the capital required to make the system operable. Genesys proposed to lease the equipment to MRC, who was to make the first payment only after the system was installed and had operated satisfactorily for six months.

Funding of System Management, Software Development, and Evaluation

MRC-TV preplanning was being done in a climate of great uncertainty, encompassing at least four unknowns. How many local governments would decide to subscribe? Where were the operating funds to come from? What kind of a closed-circuit television system would Genesys design and would it be sufficiently comfortable and convenient that government officials would accept and use it? When would the system be installed and ready for use?

With the design and installation of a system apparently assured, MRC's next concern was with its utilization. It would be neither a realistic way to undertake such an innovation, nor would it be consistent with MRC's operational policy, merely to put a system into operation and hope that the local governments would use it. Since MRC wanted to provide more than an on-going service of programs in the style of a television station broadcasting program, it would need to work in intimate association with local government officials. Only by doing so would the teleconferencing system be most responsive to the needs of subscribing governments.
Furthermore, it was recognized that an innovative project of the significance of MRC-TV should be carefully evaluated in design, operation, acceptance, feasibility and effectiveness for the benefit of other organizations that might wish to follow MRC's lead. Expert help was needed to adapt the system to meet the needs of its users. A final evaluation would be important to assess the achieved benefits of the system in terms of improved sharing of information between governmental jurisdictions.

The MRC approached several foundations for financial assistance. For various reasons none could participate. In one case the project fell into the purview of two different departments -- government and communications -- and for reasons of internal politics could not be done by either.

Most of the knowledgeable people who were contacted at this time had backgrounds in broadcasting or educational (instructional) television and constantly stressed the factor that they had always found most important and most expensive -- system software (programming). This influence caused MRC to be caught up in the broadcaster's thinking and to proceed with the notion that it would be undertaking television programming along conventional lines. Accordingly, it set out to obtain funding of $500,000 annually for the first three years, most of which it anticipated would be needed for programming. Only slowly did MRC realize that intergovernmental meetings are not TV programs and require no more than the planning, scripting, and production that go into ordinary conventional face-to-face meetings.

In November 1970, the Office of Management and Budget in Washington held a meeting of ten different government agencies to hear the MRC proposal, including representatives of HEW, NSF, OEO, DOT, HUD, and LEAA. After the MRC presentation many agencies showed interest in the project, but here, as elsewhere, there was a general lack of understanding of the project's importance because there was no reference point to which it could be related. If it could have been said, "This is a governmental version of the XYZ system," for instance, or "This is like Sesame Street" (a reference that is seldom omitted in promoting
any new instructional TV idea today), it might have attracted more serious attention.

One result of the November meeting in Washington was the serious interest expressed by the National Science Foundation in the MRC-TV project. To the NSF, an interactive television system of this magnitude and commitment looked like a significant social innovation. In May 1971, a one-year grant of $110,000 was received from the NSF, earmarked for the development of evaluation methodology and the collection of baseline data for subsequent evaluation. This was "Phase I" of a three-phase supportive program for system monitoring and evaluation.

When MRC was not successful in obtaining the $500,000 that it felt the first year of operation would require, it decided that county governments wishing to subscribe to the television service would be asked to contribute $14,000 a year. If nine counties subscribed, an income of $126,000 would be generated; eventually, with 17 subscribing counties, this income would amount to $238,000 annually. Of course, operating expenses would be greatly increased by the time 17 counties were involved, and it was clear that additional operating funds would be needed. In fact, some additional funds did come from the presentation of seminars and training courses, as discussed in Sec. IV.

By the summer of 1971, a year in which cable TV seemed to many to have a future of unbridled growth, enthusiasts expected that in a few years' time the "wired city" would become a reality. MRC was frequently advised to delay development of the system until the metropolitan area was wired, at which point it would be possible to interconnect existing systems. But this was speculation, while the need for intergovernmental coordination was current.

Others advised MRC not to go it alone, as a government system only, but to form a gigantic metropolitan area consortium, incorporating major universities, teaching hospitals, and other institutions as users of a common system. However, MRC felt its hands were filled with the problems in its own familiar terrain, and that the consortium idea might have been so unwieldy that the entire project might have failed to get off the ground. Rather than wait for new technology that might not develop, or
the cooperation of other institutions that might not materialize, MRC decided to go with what it alone could bring into existence.

In retrospect, the strategy pursued during those preplanning months was sound. MRC avoided the "big project" approach with its flashy technology and excessive publicity -- the big press conferences, communication seminars, symposia, and colloquia. MRC felt it wise to avoid depending on a single sponsor, whether foundation or federal agency. MRC was dependent on the Genesys Corporation and its lines of credit, but this was unavoidable since MRC had no available alternatives.

Underfinancing continued to be MRC's biggest problem. Clearly, the projected first-year-of-operations staff of 20 people, including clerical personnel, and the estimated program budget of nearly $200,000 yearly would have to be drastically scaled down.

PLANNING

Chronological Summary

Figure 3 shows a 29-month chronology of events that occurred after the preplanning stage, from the signing of the equipment contract in September 1971 through January 1974. The activities involved in planning are on the left side of the chart (1971, 1972); the activities and problems of the system's development and operation are on the right side (1973).

In September 1971 MRC and the Genesys Corporation signed a contract covering a 14-year period and requiring ten payments to Genesys of approximately $105,200 per year, increasing by $9000 for each county site added and by an additional $7200 for the central facility after the first two years. Nearly half a million dollars in equipment was to be installed; however, the first payment was not to become due until six months after the system was in full operation.

MRC-TV's next landmark was the move into its present headquarters in the World Trade Center in October 1971. The World Trade Center suite provided 5000 square feet of office and production space with room for a studio and control center, technical maintenance, and program materials
**Fig. 3—Chronology of MRC-TV events: 1971-1973**
preparation, plus a sweeping view across New York Harbor, Staten Island, and industrial New Jersey.

**Equipment Design**

**MRC-TV Requirements.** The MRC-TV system was something quite new to all who were involved; how a ten-location interactive television system should be configured was yet to be determined. Fortunately, Genesys had the benefit of a recent success in designing and building interactive instructional systems at Stanford University and the University of Minnesota. By means of these systems, graduate engineering courses are fed to learners on-the-job in industrial plants. Most other operating systems (the Massachusetts General Hospital Telemedicine system, one or two executive conference systems between bank offices, a police system in St. Louis) were essentially designed for communication between only two points at a time, although some provided a switching feature so that the two points could be chosen from a number of possibilities. The Omaha Veterans Administration Hospital-University of Nebraska Medical Center system, with its eight-location hookup, is an excellent example of a multilocalional switched system, but was not observed by either MRC or Genesys at the time. In any case the MRC-TV system, because of its need for real-time interconnection between at least ten points, and because of the constraints imposed by the few microwave channels that were available, required a design considerably different from any of the preceding systems.

It was clear that MRC-TV would have to be a switched system. If it were to be unswitched, it would require, even at the ten-location stage, ten omidirectional transmitters on the World Trade Center, operating on ten different frequencies. Each county facility would have to be equipped with nine receivers and nine or ten monitors.

A switched system, on the other hand, allows one channel to handle many transmissions sequentially. However, this raised questions about how a switched system should be designed so that its users are not constrained by operating requirements. Ideally, a teleconferencing system should be transparent to the user; he should be able to put his
entire attention on what he is saying and hearing, without distraction from the medium. There was no precedent, however, no model of a ten-location, two-way television system for the designers of MRC-TV to follow. The MRC requirements were analyzed and design changes were recommended by Rand, but by then installation was already under way and had to be completed as planned. When the system was finally in experimental operation, however, a series of adaptations were worked out, described in Sec. VI, that brought system operation closer to what was needed.

The Stanford Model. Because the Genesys-built Stanford system came the nearest to being a model after which the technical and operational aspects of MRC-TV could be designed, it is interesting to briefly compare the two. The Stanford system is a one-way TV system with audio feedback, and it uses the ITFS channels for transmission; it is multi-channel, and most important to MRC, it was conceived as a unified and functioning system. It utilizes four outgoing channels in the ITFS band (in present use these are often operating simultaneously), but has no return video links -- most of the receiving sites have FM radio links for voice feedback. Five studios are switchable to any of the four transmitters (Fig. 4). The MRC-TV system was not apparently different, except that it required ten studios (nine counties plus WTC) switchable to one transmitter. The hidden difference was that in the MRC-TV system, switching had to be done during interaction, between utterances in a conversation, rather than between class sessions as in the Stanford system. This need was to make some essential changes necessary after the system was installed. The two diagrams in Fig. 4 compare the Stanford with the MRC-TV system.

Informing Potential Users Related to Government

While equipment design was under way, planning had begun in earnest, and MRC began informing other potential users about the system. This was done for two purposes: to assure that the system's potential usefulness was fully realized and not overlooked by agencies that could legitimately benefit from its use; and second, possibly to uncover some
Fig. 4 — Comparison of MRC-TV with Stanford University system
auxiliary funding sources. The three state telecommunications coordinators were alerted as were the state educational systems. After determining that MRC-TV would threaten none of their present activities, most of these agencies showed little interest. The State University of New York people were well informed about developments in the interactive telecommunications field, but they saw little direct application of the MRC-TV system to their immediate uses.

Data system operators and data equipment suppliers were also contacted, as well as data users such as the Environmental Protection Agency and the Tri-State Regional Planning Commission. There was little interest from either quarter; many expected MRC to line up suppliers and users of data or to provide data banks.

Earth Satellite and remote-sensing people were also contacted, and among these the U.S. Geological Survey showed the keenest interest. Still there seemed to be no immediate or direct application for MRC-TV. MRC specifically stayed away from existing cable television systems during this period; both New York and New Jersey were under moratoriums against the granting of new franchises, and it was considered best to wait for later developments in this area. In recent months some local cable systems have contacted MRC offering a modest fee for the right to replay MRC-TV videotapes over their cable systems, thus discharging part of their responsibility to transmit locally originated programs. While not all MRC meetings would be appropriate for this use, many would probably have their value increased by being shown to the general public.

In addition, MRC wrote or phoned representatives of over 500 professional organizations in the metropolitan area, asking about their interest in using the system. The only interested response to this effort came from the New Jersey School Teachers Association, which has not actually used the system as of this writing.

MRC also contacted two groups dedicated to encouraging utilization of the cable television channels that were becoming available for public, educational, and governmental access. One of these was "Open Channel"; the other was the "Alternate Media Center" (AMC), associated with New York University. It was hoped that MRC-TV and AMC might develop some
sort of symbiotic relationship through which MRC would make the system available for various community uses, while the AMC would help in planning program techniques or improve some ways in which government groups might use the system. Unfortunately, the time was not ripe for this in 1971, but it is possible that something of the sort may yet eventuate, perhaps after a large number of one-way reception sites have been established. MRC-TV today is too limited in its reach to interest these organizations or the community groups that they assist.

By and large, then, MRC's early attempts to include users other than local government officials in its planning bore little fruit. Possibly the system's attractiveness was reduced because reception was to be limited, at first, to few conference rooms in county headquarters. It is more likely, however, that many potential users, having no point of reference, did not understand the nature of the system and will have to see it in operation before really knowing whether it is adaptable to their needs.

**Canvassing of Local Government Participants**

One of the most important aspects of early planning was to organize intergovernmental meetings groups, most of which had not existed before. MRC started with a list of 101 possible groups (see Table 2), which it eventually reduced to the 25 groups shown in Table 5, Sec. IV. (All but three of these, incidentally, held at least one meeting before the end of 1973, and several held three or four.) Long rosters of the names of individuals who might be interested in each subject area were compiled.

Meanwhile, during 1971 efforts were proceeding to persuade the chief elected officials of county and municipal governments to vote for participation in MRC-TV and to take the necessary legal steps to make it official and to appropriate the $14,000 fee. Each county government was asked to appoint one official as its MRC-TV coordinator, who would be responsible for maintaining close liaison with MRC-TV personnel and performing such functions locally as contacting those who should be involved in planning the intergovernmental special interest meetings and passing the word along when meetings are planned and scheduled.
### Table 2
**PROGRAM AREAS**
*(expanded listing)*

#### A. MRC POLICY COMMITTEES
1. Board of Directors  
2. Metropolitan Development  
3. Community Service & Information  
4. Intergovernmental Relations  
5. Environmental Development & Control  
6. Closed Circuit TV Policy Committee

#### B. MRC TECHNICAL COMMITTEES
7. Transportation  
8. Recreation & Land Use  
9. Narcotics Addiction  
10. Law Enforcement  
11. Future of the Region  
12. Solid Waste Disposal  
13. Water Resources  
14. Air Pollution  
15. Water Pollution  
16. Jet Noise

#### C. COUNTY AND MUNICIPAL PROGRAM AREAS
17. CCTV Technicians  
18. Public Works  
19. Community Action Councils  
20. Welfare Commissioners  
21. Village Mayors  
22. Sheriffs  
23. Town & Borough Supervisors  
24. City Managers  
25. Parks & Recreation  
26. County Supervisors  
27. Conservation Officials  
28. Budget Officers  
29. Mental Health Departments  
30. District Attorneys  
31. Human Rights Commissions  
32. Town Engineers  
33. Highways Departments  
34. Health Commissioners  
35. Purchasing Agents  
36. Hospital Administrators  
37. Ambulance Associations  
38. Water & Air Pollution  
39. Transportation Officials  
40. County Clerks/Surrogates  
41. Election Commissioners  
42. Narcotics Addiction  
43. Civil Service Commissions  
44. Fire Departments  
45. Jury Commissioners  
46. State/Federal Grant Coordinators  
47. Public Relations/Information  
48. School Boards  
49. Treasurers/Comptrollers  
50. County Attorneys  
51. County Planning Commissioners  
52. County & City Planning Departments  
53. Assessors  
54. Community Colleges  
55. Data & Computer Staffs  
56. Public Defenders  
57. Bar Associations  
58. Family Court Judges  
59. Law Enforcement Officials  
60. Water Commissioners  
61. Building/Grounds Maintenance  
62. Sewers/Solid Waste Disposal  
63. Personnel Officers  
64. Probation Officers  
65. School Districts  
66. Motor Vehicles/Traffic  
67. Child Welfare  
68. Industrial Development  
69. Geriatrics  
70. Medical Associations  
71. Model Cities  
72. Legal Secretaries/Court Stenographers  
73. Weights & Measures  
74. Volunteer Bureaus  
75. Local Housing Authorities  
76. Housing Renewal Officials  
77. Building Inspectors  
78. Zoning Boards  
79. Departments of Community Affairs  
80. Visiting Nurses  
81. Civilian Defense  
82. Extension Service  
83. Family Counseling  
84. Mosquito Control  
85. Pastoral Care/Chaplains  
86. County/City Jails  
87. Librarians  
88. County Adjusters  
89. County Architects  
90. General Service Admin/Contracts  
91. Juvenile/Domestic Relations Courts  
92. Shade Tree Commissions  
93. Superior Court Judges  
94. Veterans Affairs  
95. Consumer Protection/Affairs  
96. Youth/Teenage Services  
97. Parole Officers  
98. City Marshals  
99. Museums/Cultural Affairs/Special Events  
100. Public Safety Councils  
101. Coroners/Medical Examiners
A liaison person at each county was crucial to the success of MRC-TV. In the early operating period, county MRC-TV coordinators were invaluable in passing along praises or discontents and tipping off MRC when a department head or other official might be receptive to the idea of planning some TV meetings. In recent months the coordinators have increasingly been passing along ideas and requests from local officials.

The coordinator at each county or municipal site would assign one employee as an "operator," someone at the assistant or clerical level who would be trained to use the local television equipment, and be on hand to turn equipment on and off, adjust the cameras before a meeting, and operate the equipment before and during meetings. Both the coordinator's and operator's functions would be in addition to whatever regular duties they were already performing. Although they were to be paid by the local government, it was not anticipated that their MRC-TV responsibilities would require any extra financial commitment. Some of the local governments divided the coordinator's functions of planning and scheduling between two persons; most preferred to train two or more persons to operate the equipment.

Production and Operations Planning

A major uncertainty during the planning stage was the functioning nature of the system that Genesys was to provide. Rand recommended that the MRC staff engage in simulated production, using some inexpensive vidicon cameras and 1/2-inch videotape equipment that they had acquired earlier. The staff disagreed over the value of this, especially once the system hardware equipment installation had begun, but a few simulations were finally run and the experimenting proved valuable. Typically, two cameras were placed in two different rooms and a meeting was held between participants in each. A third location was simulated by audio means alone, with a microphone and an audio-video monitor set up for the third participant.

To simulate the proposed MRC-TV system, a 'program line' carrying the picture and sound of each participant in turn was displayed to all. Some simulated and some real meetings were held using the simulated system and were recorded on video tape. This was the MRC staff's first
chance to learn that their TV system was not like a video telephone, as some of them may have supposed, by means of which you could simultaneously hear and also see a person to whom you were talking. Staff participants in these simulations were frustrated to find that only in the listener role could they see their respondents; when speaking they could see only themselves. The need for the split-screen feature gradually became apparent as the staff realized that with a single main program channel only a split-screen image would allow the speaker, either in a county studio or at WTC, to be seen simultaneously at all sites, along with the person to whom he was talking.

The simulations were originally conceived as a means of training staff personnel in the various skills they would have to develop, such as chairing meetings by television or operating the control equipment. It was recommended that the main control console, which had already been delivered, be wired first, so it could be used in the simulated system. Had MRC-TV begun operations when first planned (summer or fall of 1972) there would have been no time for experimental operation. Simulation would have allowed the staff to experiment with the system and determine needed adaptations before it went into actual use.

Delayed anyway, MRC chose instead to accept another recommendation, that they go gradually into operation without the opening fanfare and full schedule that they had planned. The system was wisely not inaugurated until the tenth of October, over a month after the start of full operations, three months after the first experimental meetings.

A staff training period in the development of a system like MRC-TV is essential, but either a system or a reasonable simulation must be available to use in training. A certain number of man-months are required, however, for all of the activities that must precede the start of operations, and training with a simulator will not save time if the staff is small (as MRC was) and other preparations must be neglected. Simulation is most valuable if time is short, if there is a deadline date for the start of operations, and if the system will probably not be installed in time for very much experimental operation. Any amount of simulation, of course, will reduce to some extent the amount of
experimental operation required. The best procedure is to set no inflexible dates or, if this is unavoidable, set them farther along than the most pessimistic estimates of system readiness.

Thirteen man-months of professional personnel were devoted to the two-month MRC-TV experimental operation period. We recommend that at least 30 man-months of staff time be allowed for staff training and the development of a program service such as MRC's. If two months of experimental operation are included, development should begin, for a staff of five professionals, at least six months before the operation date. The chronological chart (Fig. 3) shows an expenditure of 186 professional man-months between the signing of the equipment contract and the start of operations. Most of this, however, is attributable to the fact that MRC was still operating in the conventional manner, organizing conferences, administering seminars and the like; not all MRC staff time was devoted to planning and developing the television system. The time devoted to these purposes was close to the 30 man-months noted above.

HARDWARE INSTALLATION

Whenever a project with innovative features is undertaken, time estimates based on prior experience are invalid. Obviously it is important to allow a contingency factor for unanticipated events such as bad weather, strikes, accidents, and the like. Additional delays are likely when something new is attempted. When schedules slip by a year or two, as has happened in completing television broadcasting stations, the danger arises that potential users who are "kept dangling" will become disenchanted.

Predictably, the MRC-TV system took longer to install than scheduled -- over a year. In June 1972, equipment was being delivered in New York and at the various county sites. Genesys had one temporary man on the job, one permanent man, and had hired the services of a local contractor, who was to erect towers and hang antenna dishes. The local firm had previous experience with the New York Archdiocese ITFS system but only with dishes no greater than two feet in diameter. Most
MRC-TV dishes were 10 feet in diameter and subject to 25 times as much wind pressure as 2-foot dishes. Some of the delay and many of the initial technical problems with the system could be traced to this lack of experience.

In its February 1972 newsletter, MRC had announced that "all 10 studios will be operational this summer." The same newsletter contained a lead article entitled "MRC-TV Scheduled for Start in September." In September 1972, the newsletter announced that the MRC-TV system would be completed "in late fall with programming on a five-day-a-week basis planned to start at that time." In fact, regular programming did not start until the following September (1973), and all points were not fully debugged until October.

In July 1972 the elevator installers at the World Trade Center unexpectedly went on strike, making it impossible to proceed with the tower and antenna work on the roof or the installation of cables between the MRC-TV studio on the 24th floor and the transmitter on the 110th. They did not resume work until January 30, 1973.

The strike did not paralyze MRC-TV installation activities, however; work at the nine county sites continued without interruption and was not completed until the strike was over. Without a strike, some contract work, such as stringing cables, could have been done at the World Trade Center while work was proceeding at the county sites, and if Genesys had hired more men for the installation task, some time could have been saved. Fortunately, the MRC staff planners and program coordinators had much to keep them busy during this period.

The elevator installers' strike was in some respects a help to MRC; for it provided a logical explanation to county personnel for the delay in putting the system into operation. Otherwise it would have been a serious problem to maintain enthusiasm at the local level for a system that consisted only of a nonoperating camera and a couple of monitors in a locked room. However, MRC could not ask its subscribers to contribute $14,000 each during the year's delay to pay for a system that did not exist, and the resultant loss of $140,000 in expected income was harmful to an organization already seriously underfinanced.
At one time during the strike Genesys got permission from the Port Authority to hook up a 2-foot dish on the roof of the World Trade Center, install a telephone near it, and check out the transmissions from each county site, so that county antennas could be aimed accurately. If a technician could watch the picture at the receiving end, he could direct the panning and tilting of the distant dish until the strongest possible signal came through. The phone company was very busy when MRC made its request and advised MRC to expect a three-month delay on their rooftop phone. Although a way was found to get this temporary phone without delay, future system builders are advised to anticipate such telephone needs well in advance and make early application.

With the end of the strike (January 30, 1973) one contractor began stringing cables within the World Trade Center while another was installing the rooftop antenna. In June 1973 Genesys engineers turned all the equipment on and checked it out; it all worked, after a fashion, and was officially accepted. Another four months were required, however, before all the initial bugs were removed and the system was operating reliably.
IV. PROGRAMMING

MRC-TV is designed to enable people at many locations to hold meetings via a teleconferencing system; consequently, the system's "program content" consists mainly of meetings of various kinds. At present, MRC-TV broadcasts about 30 hours per month. A typical program schedule, as illustrated by the October 1973 MRC-TV calendar shown in Fig. 5, lists some 22 meetings that can be classified into four types. The largest category is the intergovernmental meeting groups (11 sessions in October) in which people from several counties with common interests and responsibilities get together once a month or so to exchange experiences, discuss common problems, or question officials of state or federal governments about such matters as recent regulations or new funding sources. In the first week of October, three such meetings were held: the Finance and Administration officers met to discuss the Highway Trust Fund; the Social Services people met with an expert from Nassau County to discuss the new No-Check Welfare; and the Purchasing officers discussed "Combating Inflation in Government Purchasing." In this last instance the chairman was located at Westchester County.

The second type of meeting is a training course session exemplified by the Supervision and Management course that met seven times during October on Mondays and Fridays. This course comprised 16 sessions, and 85 students were enrolled; it is discussed in more detail later.

The third category is "specials," and includes meetings of general interest to a wide spectrum of government people; many of these are one-time-only meetings, such as the Inauguration Day ceremonies listed for October 10. The Flood and Hurricane seminar, also to be discussed later, consisted of five 2-hour sessions.

The fourth category could be entitled "MRC-TV Management." It includes meetings such as the three get-togethers of group leaders of the Supervision and Management course to discuss course progress, and the two meetings of MRC-TV coordinators (one official at each county) to discuss MRC-TV operation in general.
Note: Initials indicate staff member responsible for each conference.

Fig. 5—Typical MRC-TV monthly schedule.

<table>
<thead>
<tr>
<th>MON</th>
<th>TUES</th>
<th>WED</th>
<th>THUR</th>
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For further information, call [Contact Information].
MRC-TV STAFF

MRC-TV staff has varied between 10 and 13 persons, one-quarter to one-third of whom perform clerical duties. At present, there are eight professionals and three clerical.

Of the eight professionals, two administer MRC—the executive director and the planning director. Two others—communication director and technician—operate MRC-TV. One is responsible for all instructional programming, and the remaining three spend most of their time organizing meetings, assisted part time by the two administrators. Thus the equivalent of four staff members is devoted to planning meetings, each preparing two to four specials or intergovernmental meetings per month.

ORGANIZING MEETINGS

Most meetings are scheduled three or four weeks in advance so the monthly schedule can be prepared, although meetings can and have been organized in a few hours' time when a need arose and time was available on the system. Much of this organizing is done through the local MRC-TV coordinators; individuals who indicated they would participate are reminded by phone the day before their meeting, usually by MRC clerical personnel. In general, the procedure for conceiving, organizing, and preparing for a teleconference meeting is little different from what would be done under conventional circumstances. "Programs" are not written or prepared in the television sense, nor is there formal rehearsal of any studio presentation, although individual speakers may go over their presentations at home or before their own staff members, again much as they might for a face-to-face meeting. Thus there is no need for a production or studio crew at MRC-TV, as there is in conventional studios. Since the cameras are remotely controlled by the control operator, there are no cameramen.

A source of modest amounts of additional operating funds was forthcoming when the opportunity arose to use the system to present, distribute, and implement training courses and special seminars for which outside funds were available.
SURVEY OF MEMBER GOVERNMENTS' TRAINING NEEDS

One of the first actions taken toward using MRC-TV to train government personnel was to determine the nature of the Civil Service employee population of the MRC-TV area, and the needs that member governments felt for in-service training. Eleven different county and municipal government administrators, representing an area containing over 50,000 county and municipal employees, were contacted and polled by mailed questionnaire. From the data collected, a list of job classification categories and numbers of employees in each category at each jurisdiction was prepared. The results showed that of the jurisdictions surveyed, only Nassau County had a continuous in-service training program, and its program was for only 75 percent of its county personnel. There were particular needs for training programs for almost 5000 employees—commissioners, department directors, and first-, second-, and third-level supervisors. Public Works Departments were listed most often as having the greatest need for in-service training; hospital personnel was next, but beyond this there was little agreement. The need appeared to be widespread.

SUPERVISION AND MANAGEMENT COURSE

The first of the specially funded program projects to train government personnel was the course in Supervision and Management offered by the New Jersey Public Service Institute. It consisted of sixteen 1-1/2-hour sessions and was taken by 85 civil service people scattered among all ten locations.

Before the proposal was drafted, the MRC project director visited each local MRC-TV coordinator to discuss the concept of the project. The idea was enthusiastically received and an advisory committee was formed consisting of the personnel directors from each member government. Its first meeting was held in November 1972. Not only were governments of all nine locations and New York City involved in planning for this course, but personnel directors from an additional seven counties (counties that will join MRC-TV when it is expanded to 17) also expressed an interest in taking part in the program.
Between November 1972 and the date when funds were formally available, MRC staff people and the advisory committee held several meetings, wrote a proposal, and submitted it to the U.S. Civil Service Commission. In the ensuing negotiations, matching funds required by the Civil Service Commission were pledged by the three states whose counties and municipalities were participating. New York and Connecticut pledged financial contributions, while New Jersey decided to contribute "services in kind" by donating the services of consultants from the New Jersey Public Service Institute.

On March 1, 1973, the "preplanning" phase of the Supervision and Management course project reached its culmination with the formal notice that a $30,000 grant had been approved and the project could begin.* An additional $20,000 was shortly contributed by New York and Connecticut.

Instructional coordinators were assigned at each site to help administer and implement the course.

Although the first session was not scheduled until September 7, experimental sessions were started a month in advance. Several purposes motivated these sessions: the need to test out the proposed format and teaching methods, particularly simulation games that the instructor wanted in the course; the need to give the instructor experience teaching with interactive television; the need to give the control operator experience in switching from county to county for immediate response; and the need to train the instructional coordinators. Five preliminary sessions were held during August; some involved interaction with persons at county locations, particularly when innovative methods such as gaming were being tried out. The instructor was later able to run videotape recordings for a more objective look at what he had been doing. A system-wide conference between instructor, instructional coordinator, and all the local course coordinators took place after each session. This proved so valuable and generated so many useful comments from local course coordinators that it became a regular part of general course administration.

*Grant No. 73-NY-03 funded under the Intergovernmental Grant Program.
Interactive Instructional Television: Some Observations

The few courses that have been offered so far on this system represent a new breed of instructional TV. Taking advantage of the interactive nature of the MRC-TV system, instructors have been able to teach socratically, constantly asking questions as they would in the classroom situation. There was one difference, however; in the classroom, students are questioned individually; in the Supervision and Management course, the participating group is questioned and the individual answers, volunteers, or is selected by the local instructional coordinator. The interaction that follows, however, is direct and personal between instructor and individual student (see Fig. 6). The instructors felt that in using the MRC-TV system, they were able to teach classes of up to 100 persons with something at least very close to the interpersonal rapport that they were used to achieving with classroom groups of 20.

Persons who have observed socratic teaching with two-way television can be expected to accept this statement, and to guess that these instructors are probably right. Persons who have not observed it can be expected to doubt intuitively, either the statement, or the existence of what the instructors say they feel. This might make a good problem for applied research, using varying types of classes, instructors, learners, subject matter, and so on.

To visitors in the MRC-TV studio, the Supervision and Management course looked like a strange kind of instructional television indeed (see Fig. 6). Periods of intense interaction were alternated with periods of up to 10 or 15 minutes during which neither the instructor nor anyone else said anything at all. All that could be seen on the preview monitors was the tops of people's heads as they bent intently over some individual paperwork, a move perhaps in one of the games. One visitor asked incredulously if this wasn't a pretty boring kind of course. "Boring to whom?," he was asked. "Not to those participants you see on the preview monitors -- they are all busy. To whom then? Only perhaps to you and me. After previewing nine sites, you have seen the total audience that is watching this program. There is no one else."
Instructor Alan Quinn, with New York City participants in the WTC studio. Right, Quinn handles a question from a county participant.

Participants at other sites concentrate on individual work during a few minutes of silence, then discuss the problems they encountered.

Fig. 6 — The supervision and management course
The broadcasting syndrome, which includes the abhorrence of dead air, has so shaped our attitudes toward today's instructional television that its programs must be designed, in this respect at least, for the general viewer, non-learner audience that may happen to be looking in. The programs must thus be continuous presentation -- they cannot pause while learners do something themselves -- application must wait until the program is over. Hence instructional TV is generally limited to lesson presentation. A television course in which air time is coterminous with classroom time, and thus includes the full scope of classroom activities, is quite different from what we are used to seeing on the instructional TV screen.

**Evaluation**

At the conclusion of the Supervision and Management course a questionnaire was circulated to all enrollees, asking for an anonymous return. All 85 enrollees responded. The resultant data were broken down by counties, but will be reported here only in the aggregate. In general, there were no particular surprises; the criticisms received were already well known to course administrators, and steps are under way to make changes before the course is offered again. The results of the questionnaire are presented here in outline form.

<table>
<thead>
<tr>
<th>Question</th>
<th>Percent of Those Who Responded</th>
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<tbody>
<tr>
<td>1. In your estimation, was this course</td>
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<tr>
<td>A. Too sophisticated, too fast-paced, or too hard to understand? ..........</td>
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<tr>
<td>B. Just right and easy to understand .......</td>
<td>50</td>
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<tr>
<td>C. Too simple or too slow-paced ........................................</td>
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<td>D. Too verbal and repetitious ...........................................</td>
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<td>2. How was the instructor?</td>
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<td>A. Wonderful ..........................................................</td>
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<tr>
<td>B. Effective ..........................................................</td>
<td>63 97</td>
</tr>
<tr>
<td>C. Adequate ............................................................</td>
<td>24</td>
</tr>
<tr>
<td>D. Less than adequate ..................................................</td>
<td>2</td>
</tr>
<tr>
<td>Question</td>
<td>Percent of Those Who Responded</td>
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<td>-------------------------------------------------------------------------</td>
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<td>3. What about participation from the county locations?</td>
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<tr>
<td>A. It was helpful when our group participated</td>
<td>42</td>
</tr>
<tr>
<td>B. It was helpful when other groups participated</td>
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<tr>
<td>C. I would have preferred a straight lecture presentation</td>
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<td>4. Did the 90-minute sessions seem too long?</td>
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<td>Yes</td>
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<td>No</td>
<td>78</td>
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<td>5. Many examples from business and industry management were used.</td>
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<td>Were you able to relate to these examples?</td>
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<td>Yes</td>
<td>80</td>
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<tr>
<td>No</td>
<td>20</td>
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<tr>
<td>Would you have preferred government-oriented problems?</td>
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<tr>
<td>Yes</td>
<td>81</td>
</tr>
<tr>
<td>No</td>
<td>19</td>
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<tr>
<td>6. This question listed 10 films that were used in the course asking opinions on each as to its relevancy and whether it should be kept or dropped. Each film received from 85% to 95% favorable responses, so it was decided to keep all films.</td>
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<td>7. Was the instructor's reinforcement or discussion after films beneficial?</td>
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<tr>
<td>Always</td>
<td>21</td>
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<tr>
<td>Usually</td>
<td>43</td>
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<tr>
<td>Sometimes</td>
<td>33</td>
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<td>Never</td>
<td>3</td>
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<td>8. Do you feel that the exercises and simulation games were useful and relevant?</td>
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<tr>
<td>Always</td>
<td>47</td>
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<tr>
<td>Usually</td>
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<td>16</td>
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<td>Never</td>
<td>0</td>
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</table>
9. Do you think this course may have changed your attitude toward your subordinates?
   Yes ........................................... 59 / 81
   Maybe ......................................... 22 / 81
   No ............................................ 18

10. Do you think the course may have changed your attitude toward your job?
    Yes ........................................... 47 / 61
    Maybe ......................................... 14 / 61
    No ............................................ 39

11. Do you think the course may have changed your attitude toward your fellow employees?
    Yes ........................................... 56 / 69
    Maybe ......................................... 13 / 69
    No ............................................ 31

12. The following is a list of some possible courses that MRC could offer during 1974. Please check those that you might be interested in taking.

   A. Supervision II for County and Municipal Employees -- an advanced course in supervisory techniques ......................... 64
   B. Writing communication for secretaries ........ 6
   C. Writing communication for professionals ......... 34
   D. Improving communications with the public ........ 32

On the basis of the success of this course, MRC plans nine courses during 1974 in the supervisory and clerical fields. These will be offered in cooperation with the New Jersey Public Service Institute, the New Jersey Department of Civil Service, and the Nassau County Bureau of Career Planning and Developing, assisted by the In-Service Training Advisory Committee.
FLOOD AND HURRICANE SEMINAR

A second training project undertaken by MRC-TV at the start of its operations was the Flood and Hurricane Seminar. It consisted of six two-hour sessions on emergency preparedness responsibilities of chief executives and department officials at the county and local government levels. Funding of $28,000 was obtained for this seminar from the U.S. Defense Civil Preparedness Agency (DCPA), which sponsored the seminar in cooperation with the New York State Office of Natural Disaster and Civil Defense and the New Jersey State Division of Civil Defense -- Disaster Control.

Staff presentations in the seminar were made by representatives of these three agencies, as well as county civil defense agencies. The staff of DCPA, Region 1, organized the curriculum and was responsible for seminar content. The MRC staff helped prepare visual materials and attended to administrative details such as contacting officials and arranging for their participation. MRC was also required to produce a videotape recording of the entire proceedings as well as one hundred copies of a written report.

Planning for this seminar started during June 1973. The programs began on September 6 and continued for five weeks with one 2-hour session per week. The sixth session was held in December as a follow-up.

There were 116 participants for the first session, and an average of 100 per session thereafter, all from counties in New Jersey and New York; Connecticut did not participate. Two of the sessions made use of instructional materials that had been prepared and mailed to all participants in advance.

Evaluation

An evaluation form was sent to the participants at the close of this seminar, but only 35 out of 120 were returned. The questionnaire was the open-ended essay type and is not as easy to summarize as an objective questionnaire. One yes-or-no question, however, epitomized the entire questionnaire: "Do you feel that disaster preparedness information can be effectively presented and discussed by means of the MRC-TV system in
the future?" The response to this was a unanimous yes, 35 votes to zero.

Asked which presentations during the seminar were most and least beneficial, about 40 percent declined to make a selection, saying they were all useful. Eighty percent indicated they would like to participate in an extra follow-up session to be held two months later. A question asking what types of information the respondent would like to see presented in the future brought 22 different suggestions. Twenty-one suggestions were offered on how to improve exchange of information via MRC-TV. While most of these consisted of new topics and possible organizational improvements, others suggested shortening the programs, scheduling them less frequently, keeping them within time limits, and cutting off long-winded local speakers. Six respondents suggested that the chairman should stop introducing people who "want to see themselves on TV" and introduce individuals only when they have something to say.

The MRC Project Report on the seminar noted that the sessions tended to run slightly over the allotted two-hour period, "due primarily to time consumed by the irrepressible tendency of county civil defense directors at each county television facility to introduce each of their guests." Considering that 116 persons participated in the first session, it is clear why such behavior was totally impractical for a seminar this large. These introductions were made doubly meaningless because they were covered, generally, in wide shot, and if one lost track of the order of introduction it was difficult to see the slight self-conscious look and the short nod that identified the person whose name had just been spoken. Perhaps the introductions would not have been so awkward had the county operators had more experience and training, but the seminar was undertaken during the first month of MRC-TV operation, when the staff was still learning how to handle the equipment.

ENVIRONMENTAL PROTECTION AGENCY SEMINAR

A third training project done under contract and hence supported by outside funds was the Special Regional Air Pollution Seminar. The first three sessions of this seminar had been held conventionally in
meeting rooms in New York, New Jersey, and Connecticut; the last three sessions were held via MRC-TV. The first conventional meeting, held in New York City, was attended by 150 New York State and City people. The second meeting, held at Jersey City State College, was attended by 125 people representing urban and suburban governments of New Jersey. The third meeting, held in Westport, Connecticut, was attended by 95 people from the Connecticut area. The last three meetings, held via the MRC-TV system, were attended by 275 different people from the entire metropolitan region. Thus, the convenience of meeting by television in local areas made a larger participation from a greater area possible for these final sessions.

The planned content for the three MRC-TV sessions was "State planning for Mobile Service controls, Traffic controls, Transit concepts, and Land Use and Indirect Source controls." Two weeks before these scheduled sessions the energy crisis began to dominate the news media and to be of primary concern to the same officials who were participating in the Air Pollution Seminar. In response to this demand, the MRC-TV sessions were revised, replanned, and renamed "Transportation and Energy Crisis Seminar." The result was a well-received series responsive to the need to relate the state's plans for air quality control to the needs for energy conservation.

The Environmental Protection Agency made a grant of $28,000 to MRC to cover the costs of planning and administering the seminar's three conventional and the three 3-hour TV sessions. Planning began for this seminar in January 1973, two months ahead of the first meeting. The major revision of content was accomplished in the last eight days before the TV sessions were held in December.

ANALYSIS OF ATTENDANCE

Table 3 displays the attendance data that could be obtained on the meetings each month for the 25 intergovernmental meeting groups, special programs, and training courses. Data on the total number of people at all county sites participating in each program were kept carefully from July through September, but are only partially complete for October and November. With the data that we do have, we can note the following patterns.
Table 3

INTERGOVERNMENTAL MEETING ATTENDANCE
AT LOCAL SITES
(July-January, 75 percent sample)

<table>
<thead>
<tr>
<th>No. of Participants at a Local Site</th>
<th>Number of Local Groups with This Attendance</th>
<th>Percent of All Local Groups</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 person</td>
<td>126 groups</td>
<td>48 percent</td>
</tr>
<tr>
<td>2 people</td>
<td>71</td>
<td>27</td>
</tr>
<tr>
<td>3 &quot;</td>
<td>28</td>
<td>11</td>
</tr>
<tr>
<td>4 &quot;</td>
<td>18</td>
<td>7</td>
</tr>
<tr>
<td>5 &quot;</td>
<td>8</td>
<td>3</td>
</tr>
<tr>
<td>6 &quot;</td>
<td>6</td>
<td>2</td>
</tr>
<tr>
<td>7 &quot;</td>
<td>3</td>
<td>1</td>
</tr>
<tr>
<td>8 &quot;</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>TOTAL</td>
<td>262</td>
<td>100</td>
</tr>
</tbody>
</table>

The average number of county sites participating in an intergovernmental meeting and the average number of people assembled at a single county site can be estimated fairly well. The 44 meetings (July 1973 through January 1974) for which we have individual county attendance data (75 percent of the total) included 262 individual meetings of local county groups, an average of about six local groups per meeting. In 48 percent of the cases the local "group" consisted of only one person. Only about 7 percent of the individual county meeting groups contained more than four people (see Table 3). This does not take into account the large attendance seminars and training courses attended by as many as 25 people in a single county studio, nor does it count the participants at the WTC studio.

The monthly average system-wide attendance at each intergovernmental meeting has increased since July and when plotted as in Fig. 7 shows an increasing attendance rate as the meetings become more widely known and more organized. The data used to construct Fig. 7 are shown in Table 4.
Fig. 7 — Growth in attendance at county sites for intergovernmental meetings (July–Nov., 1973)
Table 5
INTERGOVERNMENTAL MEETING GROUPS ONLY FOR WHICH ATTENDANCE DATA ARE AVAILABLE

<table>
<thead>
<tr>
<th>Month</th>
<th>Number of Meetings</th>
<th>Total Attendance</th>
<th>Average Attendance per Meeting&lt;sup&gt;a&lt;/sup&gt;</th>
</tr>
</thead>
<tbody>
<tr>
<td>July</td>
<td>3</td>
<td>28</td>
<td>9.3</td>
</tr>
<tr>
<td>August</td>
<td>13</td>
<td>113</td>
<td>9.4</td>
</tr>
<tr>
<td>September</td>
<td>14</td>
<td>164</td>
<td>12.0</td>
</tr>
<tr>
<td>October</td>
<td>9</td>
<td>152</td>
<td>17.0</td>
</tr>
<tr>
<td>November</td>
<td>5</td>
<td>144</td>
<td>29.0</td>
</tr>
<tr>
<td>Totals</td>
<td>44</td>
<td>601</td>
<td></td>
</tr>
</tbody>
</table>

<sup>a</sup>All county sites.

For 25 intergovernmental meeting groups plus 11 special programs and training courses, Table 5 contains the data available on three factors: the number of monthly meetings of each group (which was 1 in most cases), the number of participating county sites (from 1 to 8), and the total attendance at county sites for each meeting (from 1 to 38). This information is given in each cell of the matrix; a dash indicates information is not available. The graph in Fig. 8 was constructed from the total meetings data in Table 5. The program load was reduced after September to more realistically match available staff resources. December had few meetings because the system was not utilized during the December 14 to January 1 holiday season.

NUMBER OF APPEARANCES ON MRC-TV

A production assistant kept records on 293 different government officials during the first three months of operation. On the average, each person had attended 1.8 meetings. The majority of individual attendances, as shown in Table 6, represented people who were encountering the system for the first time.

The speakers, resource people, and guests from state and local government, averaged much fewer appearances per individual than the local government people listed above. Probably 80 or 90 percent of
Table 5  
PROGRAM SUMMARY: JULY 1973 THROUGH JANUARY 1974  
(meetings per month, number of sites participating, and system-wide total attendance in local county studios)  

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Air Pollution Steering Committee</td>
<td>1,7,21&lt;sup&gt;a&lt;/sup&gt;</td>
<td>1,7,16</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>1&lt;sup&gt;b&lt;/sup&gt;, -</td>
<td>2</td>
</tr>
<tr>
<td>2. Chief Elected Officials</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>1</td>
</tr>
<tr>
<td>3. Community Colleges</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>1</td>
</tr>
<tr>
<td>4. Consumer Protection</td>
<td>1,7,7</td>
<td></td>
<td></td>
<td></td>
<td>1,6,22</td>
<td></td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>5. Corrections</td>
<td>1,8,12</td>
<td>1,6,18</td>
<td>1,7,26</td>
<td></td>
<td></td>
<td></td>
<td>4</td>
<td></td>
</tr>
<tr>
<td>6. County Attorneys</td>
<td>1,5,5</td>
<td>1,7,8</td>
<td>1,5,6</td>
<td></td>
<td></td>
<td></td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>7. County and Regional Planning</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<td></td>
<td>3</td>
</tr>
<tr>
<td>8. Data Processing</td>
<td>1,5,9</td>
<td>1,5,7</td>
<td>1,6,21</td>
<td></td>
<td></td>
<td></td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>9. District Attorneys and Prosecutors</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0</td>
</tr>
<tr>
<td>10. Emergency Preparedness</td>
<td>1,7,12</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>11. Environmental Protection</td>
<td>1,7,15</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>12. Finance and Administration</td>
<td>1,5,5</td>
<td>1,4,8</td>
<td>1,7,23</td>
<td></td>
<td></td>
<td></td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>13. General Services</td>
<td>1,5,9</td>
<td>1,5,7</td>
<td>1,6,13</td>
<td></td>
<td></td>
<td></td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>14. Housing Authorities</td>
<td>1,6,7</td>
<td>1,8,30</td>
<td>1,6,14</td>
<td></td>
<td></td>
<td></td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>15. Narcotics Task Force</td>
<td>1,5,9</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>16. Parks and Recreation</td>
<td>1,5,6</td>
<td>1,6,8</td>
<td>1,7,12</td>
<td>1&lt;sup&gt;c&lt;/sup&gt;, -</td>
<td>1&lt;sup&gt;c&lt;/sup&gt;, -</td>
<td>1&lt;sup&gt;c&lt;/sup&gt;, -</td>
<td>4</td>
<td></td>
</tr>
<tr>
<td>17. Personnel Directors</td>
<td>1,7,13</td>
<td>1,8,29</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>4</td>
<td></td>
</tr>
<tr>
<td>18. Police</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0</td>
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<td>19. Probation</td>
<td>1,5,14</td>
<td>1,6,15</td>
<td>1&lt;sup&gt;c&lt;/sup&gt;, -</td>
<td>1,5,16</td>
<td></td>
<td></td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>20. Public Health</td>
<td>1,8,15</td>
<td>1,4,6</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>3</td>
<td></td>
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<tr>
<td>21. Public Information</td>
<td>1,1,1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>22. Public Works</td>
<td>1,5,9</td>
<td>1,5,7</td>
<td>1,7,22</td>
<td></td>
<td></td>
<td></td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>23. Purchasing</td>
<td>1,5,9</td>
<td>1,4,4</td>
<td>1,6,10</td>
<td>1&lt;sup&gt;c&lt;/sup&gt;, -</td>
<td>1&lt;sup&gt;c&lt;/sup&gt;, -</td>
<td>2&lt;sup&gt;c&lt;/sup&gt;, -</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>24. Social Services</td>
<td>1,8,11</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>25. Revenue Sharing</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0</td>
</tr>
<tr>
<td><strong>Total meetings</strong></td>
<td>3</td>
<td>13</td>
<td>14</td>
<td>12</td>
<td>9</td>
<td>3</td>
<td>5</td>
<td>59</td>
</tr>
</tbody>
</table>

**Special Programs and Training Courses**

| 1. A-95 Review Project | 1<sup>a</sup>, -16 | | | | | | 1 |
| 2. Supervision and Management Course | 5<sup>a</sup>, - | 6<sup>a</sup>, - | 7<sup>a</sup>, - | 5<sup>a</sup>, - | | | 23 |
| 3. Supervision and Management Group Leaders | 2<sup>a</sup>, - | 3<sup>a</sup>, - | 2<sup>a</sup>, - | | | | 7 |
| 4. ABC Shorthand Course | | | | | | | | |
| 5. Effective Writing Course | 5<sup>a</sup>, - | 1<sup>a</sup>, - | 1<sup>a</sup>, - | | | | 3 |
| 6. DCPA Flood and Hurricane Seminar | 1<sup>a</sup>, - | | | | | | 2 |
| 7. Tri-State Regional Planning Commission | | | | | 1<sup>a</sup>, -28 | 3<sup>a</sup>, - | | 1 |
| 8. Special Regional Air Pollution Seminar | | | | | | | | |
| 9. Emergency Meeting: Commissioner of Highways | 1<sup>a</sup>, - | | | | | | 1 |
| 10. New York State Office of Planning Services | 4<sup>a</sup>, - | 3<sup>a</sup>, - | 2<sup>a</sup>, - | 2<sup>a</sup>, - | 1<sup>a</sup>, - | | 13 |
| 11. WRC-TV and County Coordinators | | | | | | | | |
| **Total meetings** | 1 | 9 | 17 | 13 | 10 | 5 | 7 | 62 |

Grand totals

| 4 | 22 | 31 | 25 | 19 | 8 | 12 | 121 |

<sup>a</sup>Means 1 meeting was held during the month, 7 sites participated, a system-wide total of 21 persons attended. Attendance figures do not contain numbers of people in WRC studio.

<sup>b</sup>Dash means data not available.
Table 6

NUMBER OF MRC-TV EXPERIENCES, 
BY INDIVIDUAL

<table>
<thead>
<tr>
<th>MRC-TV Experience</th>
<th>Number of Individual Appearances</th>
<th>Percent of Total Appearances</th>
</tr>
</thead>
<tbody>
<tr>
<td>First</td>
<td>295</td>
<td>56.0</td>
</tr>
<tr>
<td>Second</td>
<td>99</td>
<td>19.0</td>
</tr>
<tr>
<td>Third</td>
<td>66</td>
<td>12.0</td>
</tr>
<tr>
<td>Fourth</td>
<td>45</td>
<td>9.0</td>
</tr>
<tr>
<td>Fifth</td>
<td>19</td>
<td>4.0</td>
</tr>
<tr>
<td>Sixth</td>
<td>1</td>
<td>0.2</td>
</tr>
<tr>
<td>Total</td>
<td>525</td>
<td>100.0</td>
</tr>
</tbody>
</table>

such individuals have been encountering the system for the first time. As time goes on these percentages may change slightly, but not greatly, say, over two years, due to the constant turnover of personnel in most branches of government.
V. THE SYSTEM AND ITS OPERATION

MRC-TV CENTRAL FACILITY

Figure 9 diagrams the equipment that Genesys installed at the central point -- the One World Trade Center building in downtown New York. Switching headquarters are located in the MRC suite on the 24th floor, in the control room shown at the bottom right. The output from the switching and control equipment is then fed to the 110th floor to the main "program" transmitter and thence to two pylon antennas on the roof of the building. Each of these covers an 180-degree angle, one facing north, the other south, and taken together they transmit omni-directionally.

The main WTC transmitter operates only 10 watts; by contrast, commercial broadcasting stations are allowed thousands of times this much power. As a result, the MRC-TV signal cannot be picked up on an ordinary rooftop TV antenna. It can only be received by gathering a large amount of it in a parabolic reflector (microwave dish) which must be larger as its distance from the transmitter increases. At most sites a 10-foot dish is needed; some of the closer sites can use smaller dishes.

Pylon receiving antennas are mounted on the World Trade Center roof, and these antennas pick up the microwave picture and sound signals from the nine outlying locations. These signals are then converted to regular television frequencies and fed to receivers in the 24th floor control center. The central WTC studio, presently equipped with two cameras, constitutes a tenth source of picture and sound that the control operator may select to be transmitted. By forming a split screen, the operator may transmit pictures from two locations simultaneously. Figure 10 contains several shots of the WTC studio facilities.

MRC-TV LOCAL FACILITY

Figure 11 diagrams a typical county facility with its two parabolic reflectors mounted on a tower or other rooftop support, where they can
Fig. 9 — MRC-TV facilities at One World Trade Center
WTC control center with WTC studio beyond

WTC control center

WTC studio program monitor with control center beyond

Film and slide projectors make it possible to incorporate these materials into WTC presentations.

Fig. 10 — MRC-TV facilities at the World Trade Center
Fig. 11 — Typical local facility
be in line-of-sight with the World Trade Center building. The signal from the WTC is received, converted immediately to a standard television frequency, fed to a receiver and to the program monitor. A camera is mounted just above this monitor, which can be remotely controlled from a small console, usually placed at the side of the conference room (see Fig. 12). Participants naturally watch the monitor, and because the camera is sufficiently close, appear to be looking into the camera (see Fig. 13). The console output is fed to a 10-watt repeater transmitter located where it can be close to the transmission antenna on the roof. The final link in the system, known as the WTC link, is a microwave beam transmitted by the second parabolic reflector.

On top of the tower is a small omnidirectional antenna. The power from the 10-watt transmitter is divided between the omni antenna and the WTC link antenna. This division is constant; each antenna is turned off and on by a switch that directs the signal either to the antenna or to a dummy load.

The purpose of the omnidirectional antennas at the local facilities is to reach "one-way sites" in other local government jurisdictions, such as fire and police stations, city and village halls, and the like, within a 10-mile radius of each county center, either with programs relayed from the World Third Center or programs originated at the local county studio. Each one-way site would consist of a meeting room, with a viewing monitor but no camera, and probably a telephone response line to the county MRC-TV conference room. One-way sites are expected to develop gradually according to local need, at the option and expense of local government. Since only Stamford, Connecticut, has at this writing taken advantage of this option, the remaining eight omnis are not yet being used. They are completely hooked up, however, and are occasionally turned on.*

* In some cases it has been found that the omnis interfere with other simultaneous transmissions on the same frequency. Use of the omni in White Plains, for instance, causes bars and herringbone patterns in the pictures from Newark. The omni at New Brunswick also interferes with Newark. The Newark omni, in turn, interferes with both White Plains and New Brunswick. Beyond these three instances, no cases of omnis interfering with other transmissions have been observed, although not all
Fig. 12 — Typical local facility.

Remote-controlled camera with 10-1 zoom lens mounted above main monitor. Control console with small monitor for the local camera picture in background. Not shown: second large monitor.
Fig. 13 — A local county MRC-TV facility

A group of middle-management government administrators gathers in the MRC-TV studio at New Brunswick, New Jersey (the smallest of the nine MRC-TV studios) for a session of a training course. Participants are watching the main monitor, which is outside the picture. The second studio monitor, seen at top right, shows the picture they are watching. The image taken by the local camera is shown at lower right on the local console monitor. Thus the photograph was taken from the position of the local county operator where camera controls (not in picture) are manipulated.
OVERALL SYSTEM DESCRIPTION

Figure 14 is a diagram of the entire MRC-TV system, showing the channels used for the microwave beams from the county locations, and the central control and switching system in more detail. Proposed future county sites are shown as dotted boxes. Note that three of the outlying locations beam in on channel H-1, three on H-2, two on H-3, and one on S-5. This arrangement was necessary because of the dearth of available microwave channels in the New York metropolitan area, and it necessitated some unusual design features.

Because two sites on the same frequency cannot use their link transmitters simultaneously, yet may want to talk with each other, the WTK links must be turned on and off automatically as the control operator at WTC switches between one of these sites and another. This is achieved by transmitting switching pulses to each county transmitter via special signal-grade telephone lines. It is the service on these lines, incidentally, that gave MRC-TV a large part of its technical problems during the first six months of operation. The WTC link is kept warmed up and operating throughout a meeting. It is "turned off" merely by switching it from the link antenna to the dummy load.

The lower part of Fig. 14 is a highly simplified block diagram of the central control and switching system. An "X" across the intersection of two lines indicates the position of a switch of some kind, usually a button. The studio is represented by the area below the dashed line, the control room by the area above. At present, two remotely-controlled cameras and two monitors are in the studio, plus microphones, which are not shown.

The conference table in each studio has a small box with a request button and tally light. When the county participant wishes to be recognized, he presses this button. Immediately, his light flashes on the

combinations have been tested. It is still possible that some omnis may interfere with the one-way site reception of other omnis operating on the same channels. When these omnis are put into regular service, MRC will have to schedule their operation to prevent this interference.
Fig. 14 — Overall diagram of MRC-TV system
site selection banks at WTC, and the tally light on his black box also flashes. When he is previewed, his light becomes steady. He knows when he is on the line by seeing his picture appear, or by hearing the chairman tell him to go ahead, or both; and after he is through, he pushes the button again to turn the signal off.

The mixer and effects equipment are standard units that can be purchased from any of several manufacturers, so are shown only as plain boxes. The two mixer buses, A and B, feed both the mixer (for fades and dissolves) and the effects (for wipes and split screens). This is a standard low-cost production switcher; its controls are shown in Fig. 15 and will be familiar to nearly anyone who had had experience with closed-circuit television production. Two videotape machines, a film or slide channel as well as effects or mixer, can be punched up on the program line. The program line controls are at the lower right in the insert. At the upper right is a dial for selecting the wipe or split screen effect desired.

MAINTENANCE

Dishes and Towers

Surprisingly, the source of the greatest technical difficulty with the MRC-TV equipment was mechanical, not electronic. If anything, the electronic equipment exhibited less than the usual number of bugs after it had been built and checked out at one end of the country and then transported to the other end of the country for installation. There were no camera problems, only minor audio problems, and one down converter in the Mineola to WTC link had to be replaced. One tower had to be extended from 30 feet to 50 feet to make possible a clear line of sight over trees that did not show on the topographic map used when the system was designed.

The most common cause of weak signals or loss of transmission was physical movement of towers or dishes at the county locations. A spell of very windy weather occurred in October 1973 during which towers that were not sufficiently guyed twisted back and forth, thus aiming their
A portion of the WTC control console. Monitors from left to right show (1) site previewed on site selection bank I in panel below (nothing being previewed), (2) site previewed on site selection bank II, (3) program picture being broadcast from WTC omni transmitter, (4) WTC studio camera no. 1, (5) WTC studio camera no. 2. A standard production switcher, below left, provides capability for fades and dissolves (controlled by handles at left) or wipe and split screen effects (controlled by knob in center). Knob at upper right of the switcher panel selects between six possible types of wipes or split screens.
parabolic reflector dishes at a variety of targets, and only occasionally beaming in on the World Trade Center. Since the area of a 10-foot dish is 25 times that of a 2-foot dish, it creates about 25 times as much wind resistance and hence requires 25 times as strong a guying system. Only those dishes that had been installed against walls or anchored directly into buildings survived the winds in tact. All those on towers had to be refastened, re-anchored or reguyed.

General Maintenance During a Five-Week Test Period

Early in the operational period, Rand recommended keeping detailed records of equipment troubles and maintenance action. The limitations of staff and technical time were so great (MRC employed only one technician) that it was a month or two before a form was drawn up, and another two months before it was used. By the end of January a request for maintenance data could still be provided only from memory, covering December 1973 and January 1974.

Because of the holiday period, MRC-TV operated only two weeks during December, plus three in January, making a total of five operating weeks during the period studied for maintenance and technical data. At the start of this period the WTC equipment (studio, control center, and transmitter systems) had been operating approximately 680 hours, and the county systems about 104 hours each, on the average. By the end of the period, WTC equipment had accumulated about 845 hours while the counties averaged about 121.

The period of greatest antenna trouble was nearly over by December. Only one dish had to be repositioned during December and January; it had taken a gigantic turn of about 45 degrees — which almost looked like vandalism. One other site had (and still has) a recurrent problem in the antenna — probably a damaged cable. One local omni antenna, mounted atop a tall flagpole, broke loose from its cable at the top. Flagpole climbing is a specialized and rare profession, especially in winter; luckily, this antenna is not yet in use, so the repair can wait until spring.
Most of the troubles with sound or picture could be checked on and solved by phone. Only eleven visits to county sites were made during the five weeks. One site required two visits for trouble, four required only one visit each, two required two visits, and one required three.

The predominant source of trouble during this period (and prior to it) was failure or interference in the telephone company signal lines. Nearly every site had trouble on this score. At one site a new circuit was ordered from the phone company in November, but had not yet been installed at the end of January.

The other problems were generally minor. Two sites developed a buzz in the audio; there were one or two problems with sync generators; the mute circuit that lowers speaker volume when someone speaks into the microphone (described below) opened up at one site. A bad resistor was replaced in one transmitter, a heavy hum condition was removed in another. During this period there was no need for parts replacement, all equipment was repairable.

SOLVING SYSTEM PROBLEMS

Acoustical Feedback

A basic problem in two-way teleconferencing is that microphones and loudspeakers must be closely associated in the same room, and the microphones inevitably pick up some of the sound emanating from the loudspeakers. Since this also happens at the other end of a two-way system, sounds can go round and round, building up each time, until, of levels are high enough, a feedback squeal, or "howl-round" as the British call it, develops. Someone has to turn down the volume somewhere in the circuit to stop it. This effect was a regular occurrence during the experimental period of MRC-TV and occasionally occurs today. When feedback howl occurs today, it is generally at the beginning of a meeting or during checkout before a meeting, when the county operator has accidentally turned the microphone volume up too high.
Several methods are used to reduce the amount of loudspeaker sound that reaches the microphones in a two-way studio. A frequent cause of the problem is using the microphones in their low table stands where they are so far from the speaker that the microphone volume must be turned up high. Some longer, higher stands are being obtained that will put the microphone closer to the speaker's mouth so that he won't have to hold it. But these new stands will have to be moved about the table from speaker to speaker and this may cause unwanted noise. The simplest method is to train participants to hold the microphone in the hand, close to, but below the mouth, so the speech sounds will be very loud and the microphone can be operated at a low enough level that it can barely detect the loudspeakers. MRC-TV participants have learned to use this method, either wearing lavaliere microphones or taking the microphone out of the low table stands that were provided and holding the microphone up to the mouth.

Another measure usually taken in two-way studios is to sound-deaden the studio floor, ceiling, and walls so that loudspeaker sounds do not reverberate and reach the microphone from many directions. When the county studios were prepared, Rand recommended carpeting, drapes, and other soft covering on as many walls as possible, and acoustic tile ceilings. Not all counties compiled; but most provided something, if it were only a wall of drapes behind the conference table. Far more is required and is repeatedly recommended, but this is a matter that counties must handle and is out of MRC's control.

Still another measure is to equip the two-way studio with an automatic control that will lower the loudspeaker volume whenever the microphones register a sound above a certain level. A representative example of this is the "VOX" (Voice-operated Transmitter) and mute circuits such as these were installed in all county MRC-TV studios. Some people have disliked these devices; at the Boston General Hospital VA system it was reported that people tended to push their voices because they felt they were not being heard, and became very tired after a long meeting. There have been no such complaints at MRC-TV, however, perhaps only because there have been other more serious problems, or perhaps because participants have been using the microphones close to the mouth.
Poor Picture Quality

The picture quality coming from the county studios left much to be desired, even after four months of operation. This could usually be traced to faulty video operation. Camera adjustments such as beam, target, electrical focus, pedestal and lens iris opening had been set incorrectly or had drifted from their proper settings during a meeting. Given audio intercommunication, the WTC controller could help the county controller in this. An analysis during early December, however, showed that only four counties had a telephone at the control console and in only three of these were operators clearly ordered to man the consoles during meetings. In the other locations the county operator sets up the picture prior to the meeting with or without assistance from WTC, and then returns to other work. If a picture needs adjustment, the operator can usually be reached by phone (if not in the studio, then next door to it or down the hall), told what adjustments to make, then must go into the studio to carry them out. When a meeting is not in progress the WTC controller can talk to one of these operators over the main program line while adjustments were being made. During meetings the local operator will go to the studio, make an adjustment, then must return to a phone in another room for further instructions. A special intercommunication line is necessary to solve this problem. However, all county operators must be required to attend their consoles during meetings or even this will be of no avail.

Figure 16 summarizes the major system problems, both solved and unsolved, showing when they began (and ended) and by thickness of a shaded line, how severe they were during each month of operation.
**Fig. 16 — System problems, by month**

<table>
<thead>
<tr>
<th>PROBLEMS</th>
<th>July 73</th>
<th>Aug</th>
<th>Sept</th>
<th>Oct</th>
<th>Nov</th>
<th>Dec</th>
<th>Jan 74</th>
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<tr>
<td>Equipment: Defective parts</td>
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<td>Dishes and towers poorly anchored/guyed</td>
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<td>Revisions required — rewiring etc.</td>
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<tr>
<td>Audio: Studios not sound-deadened</td>
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<tr>
<td>Poor audio operation</td>
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<tr>
<td>Poor microphone technique</td>
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<td>Video: Poor operation</td>
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<tr>
<td>Wrong switches thrown</td>
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<tr>
<td>Communication with county operators</td>
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<tr>
<td>Coordination by WTC chairman</td>
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<tr>
<td>Lack of use of visuals</td>
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<tr>
<td>Tampering at counties</td>
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</table>
VI. SYSTEM ADAPTATION: LESSONS FOR TELECONFERENCING

Without three key adaptations the MRC-TV system operation would have been so cumbersome and formal that in the opinion of some observers it might not have succeeded at all. These adaptations are (1) two-way open audio, (2) previewing facilities for the meeting chairman at the WTC studio, and (3) the black box request cue system.

OPEN AUDIO

The most crucial adaptation was a slight rewiring that allowed for "open audio" between the WTC studio and any other county that was preset on the studio switching system. The MRC-TV system had been designed according to an "audio follow video" system, i.e., it was not anticipated that audio from any source would be needed if video was not also coming from that source. This meant that a free flow of give-and-take conversation between two points would require constant and highly accurate audio-video switching between each utterance, and the overlapping of voices which is common in any free conversation would be totally impossible. Rewiring the audio so it would go out on the WTC program channel as soon as its associated video signal had been readied on the switcher made free audio interaction between the WTC studio and at least one county studio possible at all times, no matter whether the county or the WTC picture happened to be on the line.

Another stage of adaptation along this line has also been recommended by Rand, favorably received, and will be carried out when time allows. This will provide the chairman in the studio with controls to do his own preview selection and to himself switch the county he chooses onto the line.

PREVIEWING COUNTIES FOR THE WTC CHAIRMAN

According to the original design, the two monitors in the WTC studio were to be used in the same way as the two in each county studio:
the main monitor was to be switchable between the WTC program line and
the local picture, while the secondary monitor was to show the WTC
channel at all times. The limitation was that except when a speaker
was on the line in split screen he could only see himself. When in
split screen with another location he could also see that location.
For the usual participant in a county location this turned out to be
fully adequate, providing that the split screen were used when he
spoke, so he could see someone to whom he was talking. However, chair-
men at the WTC studio needed more than this -- they needed to have
better control over and less isolation from the functioning of their
meetings. At the least, a chairman needed to preview the people that
he was going to call on, so he could see if they were actually ready,
perhaps exchange a few pleasantries and greetings with them if he
wished and, most important, so he could see the one to whom he was
talking. Accordingly, the system was rewired so that whatever picture
was previewed in the control room on a particular preview bank would
appear on the main monitor in front of the WTC chairman. Generally,
each participating county would be previewed in turn, so the chairman
would constantly have someone in front of him to talk to at all times.

REQUESTING TO SPEAK

The original system design incorporated a push button in the county
console labeled "WTC link," which was to be used as a signal for request
to speak. When it was punched at the county, a labeled light began
flashing at the WTC control center. However, these lights were located
on the console in the WTC control room and were not visible to the
chairman in the studio. The original plan included the use of a studio
loudspeaker, or an intercom system, so the controller could let the
chairman know which sites were requesting to be heard. It was feared
that either of these methods would tend to interrupt a meeting, so
neither has been used. Instead, a set of cards was prepared, carrying
the names of the various counties, and the controller now merely holds
up the appropriate cards to let the chairman know which sites are
calling. The chairman selects the county he will hear from simply by
saying, "Let's go now to Nassau county." This serves also as a standby warning to the county participants involved, who then begin speaking when they see themselves on the screen.

The WTC link button at the county has one other function as well: it allows the WTC controller to preview the county. This was conceived as a simple privacy control; if a county was not actually requesting to speak (with the link button on and flashing), it would be impossible for the WTC controller to turn on* the county's link transmitter, and hence to preview the county at WTC headquarters. This effectively isolated the county studios, or rather, isolated the WTC controller from the counties. In the early experimental days when this system was still in use, the WTC controller had to call a county on the program channel and ask someone to punch the WTC link button before he could preview the site, even for technical adjustment purposes. If he was to be free to preview any county at any time, however, it was necessary to operate the system with all WTC link buttons on at all times.

Operating with all link buttons on at all times was the first departure from the planned operating procedure. Privacy became the exception rather than the rule; if desired, it could easily be obtained by turning the WTC link button off, but so far this need has not arisen. Participants seem to be reasonably comfortable with the present system.

The new operating procedure resulted in nine lights flashing at once on the WTC controller's console, and effectively eliminated the use of the link button and its flashing light as a signal for request to speak. Some other means had to be found. Raising the hand was considered, but it was feared this might be too tiring since sites had to be previewed sequentially and it might take a while for a raised hand to be seen. Each local site had been equipped with a desk

*Actually this action consists of switching the county transmitter output between a dummy load and the county's antenna. Turning a transmitter on requires several minutes of warm-up time, so all transmitters are actually kept on throughout a meeting.
name plate and it was agreed that this cardboard sign would be turned
down at all times except when the county was requesting to speak. Then
it would be turned up to show the county name.

This method, used for a few weeks, led quickly to something
better -- a "request button" built into a small black box whose func-
tion has already been described in the previous section. The system
was rewired so the site selection buttons at WTC would not flash
until this button was pressed. This button now has two functions.
First, when pressed the light begins flashing, both on the black box
in the county studio and at the WTC control center as a signal for
request to speak. The original kind of cue system is back, but now
is under the control of the participant at the county locations, not
just the console operator. Second, as soon as the county is previewed
by the WTC operator (and displayed for the chairman and panelists in
the WTC studio to see), the light on the black box stops flashing and
becomes steady. This extends to the participants the courtesy of
letting them know that they are being previewed. When they are no
longer on the line or being previewed, the light goes back to the
flashing condition, and if they then have no further desire to be
heard, they turn the entire cueing system off by punching the button
a second time.

When a county has not requested to speak but is previewed at WTC
anyway (so the controller can see if there is anyone present, for
example), the black box light on the county conference table will go
on with a steady light to let the participants know they are being
looked at.

THE SPLIT SCREEN

One very important aspect of the original design was the incor-
poration of a simple special effects generator, making it possible to
do four kinds of split screens (as described in Sec. V under the Over-
all System Description) and to wipe them in and out. * While the real

* The wipe effect is essentially a split screen in motion, one
picture growing in area while the other dwindles.
usefulness of special effects devices in previous television systems has been highly questionable, they are an attractive extra, and since becoming inexpensive have been very popular. A design for a studio control console would hardly seem complete today without facilities for fading, dissolving, split screen and wipe effects, as well as straight switching. Yet, in most closed-circuit systems there is rarely any requirement or theoretically legitimate use for any of these effects. In an interactive system such as MRC-TV with only one program channel, however, the split-screen effect is not only useful, it is indispensable for several reasons:

1. Successful interactive communication requires that each participant see (or hear) his respondent. Only then can he relate to a person rather than simply to an impersonal microphone or camera. The difference in behavior is almost like the difference between night and day.

2. In using a television system, if the participant can see his respondent at all, he needs to see him as he himself is talking, not merely after he has finished a statement and the respondent is making a reply.

3. In a single-channel system, a speaker normally will see only himself, unless he is combined in split screen. With the split-screen capability, any pair of respondents may see each other (and themselves, of course) while using a single channel. Thus, it is only when the split screen is used that MRC-TV becomes a "simultaneously two-way" video system. Otherwise it is only sequentially two-way.

One MRC-TV participant expressed the need for the split screen very well in a discussion evaluating the Supervision and Management training course. He suggested that the split screen be used more, saying that the people at his county who attended the 15 television meetings of the course had all made the same comment. "When you see the eyes of somebody you're talking to," he said, "it seems like you're there."
Michael Argyle in "Social Interaction" explains this need in specific terms.

For two people to engage in conversation there must be continuous evidence that each is attending and responding to the other. The conversation is usually initiated by two people taking up positions so that they are sufficiently close together and oriented towards each other, and by making eye contact. There must be continuous evidence during the encounter that the other is attending and responding; this is done by eye movements, head-nods and gestural reciprocity; the encounter is terminated by a withdrawal of these cues and changes in position or orientation.

...A speaker needs to know how his utterances are received -- whether the other person understands, believes or disbelieves, is surprised, agrees or disagrees, is pleased or annoyed. Without this information, the speaker does not know how to plan his next utterance. The relevant information is mainly obtained by studying the other's face: raised eyebrows signal surprise or disbelief, while the mouth and eyes show pleasure and displeasure.

A theory of split-screen design has not yet been worked out for MRC-TV. It seems evident, from the examples shown in Fig. 17, that relative size of image and relative high or low position in the frame have much to do with the relative implied importance of the two participants shown. Equality in size (Fig. 17, upper left), equality of level (upper right), or equality of both, which is a more typical split-screen format, seem to imply a relationship of equal status.

Had the special effects generator not been incorporated into the basic MRC-TV design, the opportunity for the system to be fully interactive would have been lost. However, the almost total lack of communication between the WTC controller and the operators at the locations that do not yet have phones at the console greatly reduces the opportunity to make split screens. This is another reason why the WTC controller needs a private open phone line to all local operators at

Fig. 17 — Various split screen effects.
all times. Before he can effect a split screen, each camera involved must be redirected so that the speaker in the first picture of a proposed pair is placed in one area of the screen, while the speaker at the second location is placed in another area. Then the two pictures can be combined. Camera adjustment can only be done by the county operator. Usually, split screens are done only when there happens to be room in a county's picture, and then only to combine that county and WTC, where the controller can adjust the camera; there have been few two-county split screens so far.

There is a built-in limitation on split screening that deserves mention. In the MRC-TV system, only one of the two or three channels that share a frequency may transmit at any one time; two of them may not be combined in split screen. This is a minor problem, however, and seldom arises. Of the 45 theoretically possible combinations of the MRC-TV system's transmitters, only 7 cannot be combined because they share frequencies.* Since there is no restriction on the combining of the WTC picture with any other, and nearly all split screens so far involve WTC as one of the pair, this constraint is yet to be felt.

UNSOLVED PROBLEMS

Communication with County Operators

This problem has been described in connection with both picture quality and the split screen. It is a standard requirement, in communication systems of all kinds, that a parallel channel of some sort, usually voice, must accompany the main channel or channels for technical and operational purposes. A television studio or remote pickup could not function without its intercom system. Even in professional video tape recording a second audio track, called the cue track, is

*Impossible split-screen combinations: Stamford, Connecticut/Jersey City, New Jersey; Stamford/Rockland county, New York; Rockland/Jersey City; Essex County, New Jersey/Middlesex County, New Jersey; Essex/Westchester County, New York; Middlesex/Westchester; Linden, New Jersey/Bergen County, New Jersey.
usually provided for technical communication between those who make the tape and those who play it back.

Some methods of obtaining this technical operation channel have already been discussed: the upgrading of the present telephone signal line to voice-grade, and the installation of outside telephones in each county studio. A third possibility has also been considered. Associated with the H1, H2 and H3 MRC-TV frequencies, the FCC has set aside three audio frequencies for use as "response channels" in a direction opposite to that of the ITFS transmission; however, MRC never applied for these audio frequencies. If these (or some other) frequencies are assigned, MRC-TV could set up radio communication in at least one direction, from WTC to the counties. Since this last possibility would require the most capital investment in additional equipment it has been the least seriously considered.

There is one further advantage to the intercom system proposed by Rand. If it is a party line, each operator will be able to listen in on the problems that another is encountering, and since they all have the same equipment, learn operating pointers that may make it possible for each operator to solve those problems alone when he encounters them. Even more important than this is the possibility that the county operators will feel a kinship for each other, take an interest in each other's problems, and then tend to ascribe an importance to their work which separately they might not feel, thus taking on a special identity as MRC-TV operators.

Backup Systems

One recommendation by Rand made early in the formative process concerned the need for backup systems to use in case of catastrophic system failure. Analysis of the Stanford instructional TV system showed six or seven catastrophic failures per year (defined as sufficient to cause one or more television channels to be completely down and off the air). Since the MRC-TV system is more complex than the Stanford system, Rand predicted about eleven such failures per year for MRC-TV. Because the Stanford system operates five studios and four program channels, it has redundant equipment available about
71 percent of the time. Thus, service on the Stanford system can be immediately restored by switching to other equipment, or by pulling a part out of equipment not in use and installing it in the disabled channel, a procedure requiring some five or ten minutes. MRC-TV lacks redundant cameras and transmitters; nine transmitters are located at different distant county centers and MRC employs only one technician. Considering all this, it was estimated that MRC-TV down time would amount to a mean of two days per failure. This is tolerable, however, since it amounts to only about two percent of operating time.*

Because the actual MRC-TV schedule turned out to be only one-third to one-half as heavy as the proposed schedule used to make the above estimates, more time was available for maintenance when the system was not in use. Also, counties frequently helped each other out; if people were given advance notice when their equipment was down, they simply drove to a nearby county that was operating and used its facilities. Thus mean time for repair of MRC-TV failures was somewhat less than two days.

MRC-TV has very little redundant equipment and hardly anything for backup purposes. The only real examples of redundant equipment are an extra monitor at each county and an extra camera at the WTC studio. (WTC could operate with one camera if necessary.) MRC-TV also has an extra set of two portable cameras that could be used, presumably, as backup for any of the twelve other cameras in the system (nine in county studios, two in WTC studio, plus one for films and slides). There is no backup for any of the audio-video transmitters; a failure of the main WTC transmitter could knock the entire system out of operation.

Accordingly, an audio backup system was recommended so that if a transmitter failed, a meeting could be continued simply by switching

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*Ten transmitting sites x 150 operating days/year = 1500 site days; nine county site failures x 2 days down = 18 site days down/yr; one WTC failure causes 1 day down at all sites = 10 site days down/yr; 28/1500 = 2%
to the standby audio system and carrying on in audio alone. At present, a signal-grade* telephone line to each county is used to carry the pulses that remotely turn on and off the county link transmitters. As mentioned in connection with the split screen, Rand recommended that this line be upgraded to a voice-quality line, in which case it could still carry the same pulses without affecting the voice transmission. Normally it could be used for communication between the WTC controller and the county operators. In case of emergency it would thus be available to replace the central WTC audio-video transmitter, leaving the technical people with the outside phone for communication, as at present. MRC, however, felt that it could not afford the additional few thousand dollars that this service would entail each year.

Another recommendation for a backup system was then made -- the outside telephone. It was suggested that each county be equipped with an inexpensive loudspeaker phone (about $20 each), and that the WTC studio be equipped with a Speakerphone unit (a microphone-speaker combination available on rental for less than $10/month). Although on Rand recommendation the counties had been asked to install phones in their studios, only half of them had done so, and until most do, this telephone system will not be practicable. Since MRC-TV did not have funds to pay for phone installation, local governments would have to cover the costs.

These outside phones could also provide backup for failure of the county link transmitters or the county audio equipment. Use of a loudspeaker phone at the county would not obviate the use of the regular handset, which could still be used by any participant wishing to talk to the meeting group at WTC. In the WTC studio the telephone participant would be heard on the studio Speakerphone.

The amount that should be invested in backup systems is directly related to the importance of maintaining reliable service. Commercial broadcasters stand to lose substantial amounts of money by system failures, and hence consider elaborate backup systems essential.

*Not high enough quality for speech transmission, but less expensive.
insurance. A government conferencing system, on the other hand, that is well accepted by its users, can tolerate a certain amount of down time, provided that not too many people are inconvenienced. However, there is room to be concerned about system reliability when 100 or so persons are attending a seminar or taking a training course, and especially when the event is supported by grant funds which can be jeopardized by failure.

*Switching by the WTC Studio Chairman*

In operating practice, the chairman in the WTC studio is usually the MRC staff coordinator who has been responsible for organizing the meeting. One of Rand's first recommendations was that this chairman control the previewing and switching of county participants. This amounted to a set of push-button controls duplicating, not replacing, some of those now in the WTC control room. It required redesign, rewiring and revision of the method of operation the system designers originally planned. At the time the suggestion was made, MRC was beginning to accept delivery of equipment and, being under great pressure to complete installation as quickly as possible, did not look enthusiastically on suggestions for redesign. *

*Camera Angle*

Cameras in the county studios as well as in WTC are placed quite high, on top of monitors that are on stands of standard classroom height (see Fig. 12). This places the camera lens 7 feet above the floor. In the larger studios where the camera and monitor can be

*The recommendation was repeated during early 1973, however, and in March of that year Rand made and delivered to MRC a cardboard mock-up of a proposed studio switcher. MRC supported the recommendation this time around and finally in October found time to install a set of push-button switches in the actual cardboard mock-up itself. But when an attempt was made to hook it up to the control console some circuits were shorted, necessitating emergency repairs. It is now estimated that the technicians will need at least two days to construct and install this studio auxiliary switching system. Some additional time will first be required to design it properly, and some more recently formulated requirements can now be incorporated in the design.*
15 feet from the participants, the camera's down angle is not too great, and the high position makes it possible to place people in considerable depth; one table behind another or tables set with the long axis pointing toward the camera are frequently seen (Fig. 18). When many people are in the studio this high camera angle is very useful, because a camera at eye level might not show everyone since all heads would tend to be in a single horizontal line.

Another possible advantage of the high camera placement is that the camera is out of convenient reach. This discourages tampering, although a person of average height can, by stretching, remove or replace the lens cap. There have been no camera problems at county locations, so it is considered desirable to keep the cameras high where possible. But in one or two of the smaller studios the camera may have to be lowered because the down angle can be extreme; people are seen looking down when they speak instead of looking at the camera.

Monitors in County Studios

The original MRC-TV design equipped each county studio with two 21-inch monitors: one has the single camera mounted above it; the other, mounted on a similar high stand, is placed off to the side. The monitor associated with the camera (toward which it was desirable for participants to look at all times) is switchable, so that from a control at the console it can display either the WTC picture (the main MRC-TV program line) or the local picture of the participants themselves. This is intended to accommodate the mode of use where the county is originating and distributing locally and nothing relevant is coming from WTC. The side monitor could display only the WTC picture. A third and smaller monitor is built into the control console and displays the local picture only.

During a meeting, participants see two monitors each showing the WTC picture, while the console monitor shows a picture taken by the local camera. Of course all participants must watch the monitor associated with their camera; they are undoubtedly made conscious of this, but some will tend to forget, and the sight of someone intending
Fig. 18 — Some representative pictures from local county studios.

These pictures, transmitted from various county studios, display several conference table arrangements that can seat up to ten or twelve people. Such arrangements are made possible by the relatively high camera placement, in comparison with most studio cameras. The use of 10-to-one zoom lenses, remotely controlled, allows a width of field, at a 15-foot distance, of 14 feet at the widest angle of view, and less than a foot and a half with the lens fully zoomed in.
to interact but looking off to the side at the wrong monitor is not uncommon (see Fig. 16). It has been recommended that the counties face these side monitors away, keep them for standby purposes, or place them in another room where someone may wish to monitor MRC-TV without actually participating in a meeting.

The operating consoles in some county studios are placed where the operators cannot see the main monitor under the camera. Since the small console monitor is not switchable, an operator in this position cannot watch the WTC picture. This could hinder him in properly adjusting his camera in a split screen, for instance, or learning by watching the mistakes of other operators. Therefore, we have suggested that the side monitors in such studios be placed where they can display the WTC picture to the console operator.

Some of these operating details may seem inconsequential to persons who are not familiar with the television operations; they can, however, make the difference between a man "operating blind" or constantly knowing what is going on. A basic principle in operating this complex medium is that two parallel activities are always in progress: those of the program itself, and those of the team of production and technical people who are operating the medium that transmits (or records) the program. These are the people who monitor the program, operate the switching and technical controls, manipulate cameras and the like. The facilities for these functions are frequently forgotten when the characteristics of an interactive system are described, and the human factors in the operation of such facilities are often neglected in the design process. Consider, if you will, two hypothetical systems using identical equipment, one containing a well-planned support system of intercommunication and monitoring, and the other containing a scanty and poorly planner support system. All else being equal, the first system will operate best, with the most efficient use of operating personnel, and to the greatest convenience of its users. MRC-TV still has far to go in developing an effective support system, and the several problems described here that concern monitoring and communication, when put together, take on considerable significance.
Use of Visual Materials

One important television characteristic that was expected to be particularly valuable in information-centered communication is the capacity to display visual information. So far only the training courses and special seminars have used visual materials to any extent. Rarely has a county studio transmitted any kind of visual information; it has mainly been done at WTC. This may be due to several factors, one of which is probably lack of knowledge of how to go about using visual materials. The original complement of equipment included a light folding floor easel for each studio, but probably few counties know what size TV easel charts ought to be made. Whatever the size, making visuals in advance requires more planning and preparation than county people presently put into any meeting. So far, the county participants are usually on the receiving (and responding) end of a meeting, and when they do present information themselves it is more in the nature of a spontaneous response than something preplanned.

What is needed is some means, such as the classroom blackboard, that someone could use spontaneously to make a quick diagram or write out a few key words. A small "table easel" was designed for this purpose; it is a display stand some 12 inches high and 14 inches wide that could be set up on a table beside a speaker to hold cards or other visuals roughly perpendicular to the camera so that the speaker could point to details in a diagram or could write or draw with a flow pen or felt tip marker. A cardboard prototype of this was built at WTC but was never put into service.

In the Stanford system, origination classrooms were each equipped with a remote control camera mounted in the ceiling. The camera could be focused on a specific "graphic area" on the tabletop directly beneath. Thus a Stanford instructor may write on a flat surface before him. Genesys did not equip counties with this piece of equipment because of the expense, but would have liked to install one in the World Trade Center studio. The second camera was instead mounted in the studio like the first, above a monitor, with remote control from the controller's console. The need for an overhead camera has been
felt at the WTC studio, and it may be installed in the ceiling at some later time.

Lack of training more than anything else may be the reason why so many people do not consider the possibility of using visual means to clarify what they say. If a few persons at MRC should receive a little help and encouragement in this regard and begin to make some visuals for the people who make presentations, county people may want to follow suit. Some training in use of visuals on the county level might then be welcomed.

DEVELOPING USING TECHNIQUES

Encouraging Local Participation

At first, county personnel displayed a natural reluctance to participate in meetings. At the same time the MRC staff was very much aware of the need for such participation, since the system was conceived as an interactive and cooperative means of communication. Consequently, MRC chairmen resorted to calling on specific counties for comment -- making the rounds, so to speak, to make sure that no one was left out. The procedure was fairly unpopular, and after a month or two some coordinators began to mention it as a source of displeasure. To be called on when you really had nothing to say was, they felt, unfair and embarrassing. Not only this, but to those listening it often appeared to be a waste of time.

The Supervision and Management training course was an exception. The instructor of this course wished to use his classroom teaching techniques, which included calling on students for response during lecture presentation, thus making every lecture an interactive discussion. The interactive teleconferencing system thus opened up a new dimension to instructional television and the instructor was encouraged to call for response all he wished.

By the fourth month of operation the county people had apparently overcome their reluctance to participate, the chairman allowed all an opportunity to speak up, and if individuals at a particular
county did not do so it was assumed that they really had nothing to say.

Social Interaction

An objective of most teleconferencing research is to determine the effects that various telecommunication media have on social interaction. Some psychological field studies will be made of the MRC-TV system to determine whether this system has features that make it particularly useful for some specific kinds of social interaction and perhaps not for others. Meanwhile, simple observation has contributed some anecdotal evidence that will be useful in designing future research.

There is an extensive literature on the nature of social interaction in the conventional, face-to-face mode. Argyle reviews this in his excellent book *Social Interaction*; Goffman's *Relations in Public* and Hall's *Silent Language* are other useful sources. Until the last few years the telephone was the only example of a communication medium being used for interactive purposes, and for some reason no significant research was done on the sociology of the telephone. Researchers such as the Communications Canada group at Ottawa are now beginning to study a number of media, including closed-circuit television systems of several kinds.

Argyle lists eight purposes or goals that may underlie one person's desire to interact with another. These are numbered here and reordered in the sequence in which they are most likely to occur in teleconferencing.

1. Conveying knowledge, information or understanding (teaching).
2. Obtaining information (interviewing).
3. Changing attitudes, behavior or beliefs (salesmanship, canvassing, disciplinary action).
4. Changing the emotional state of another (telling jokes, dealing with a hostile person).
5. Working at a cooperative task (most industrial work).
6. Supervising the activities of another (nursing).
7. Supervising and coordinating a group (chairmanship, foremaship, arbitration).
8. Changing another's personality (psychotherapy, child-rearing).

The British researchers of the Communication Study Group* have called these purposes "meeting tasks" and have classed them roughly into two groups: those that are information-centered and those that are person-centered.

Person-centered communication includes conference tasks such as negotiating an agreement, attempting to influence the policy of another group, enlisting support for a proposal, or settling disputes or differences. Information-centered tasks include presenting and receiving information, exchanging experiences, coordinating plans, clarifying policy, and the like. Within this dichotomy, the first two items on the Argyle list would be classed as information-centered and the other six as person-centered. Observation indicates, however, that none of these purposes exists in isolation; almost any meetings will contain a variety of tasks and objectives, and person-centered activities frequently take place, unplanned, in the most information-centered interaction. The informal, extra-task communication via MRC-TV has been highly person-centered, e.g., pre-meeting conversations, social introductions of one person to another, and the like.

It is very difficult to imagine the MRC-TV system being appropriate to its present informational uses if it were not a full-motion television system. Conventional human interaction, even when directed toward an informational goal, is loaded with interpersonal relationships. This may be especially true of people in organizations, where those succeed best who relate best to the people with whom they interact. There is much in any face-to-face communication besides the spoken word. Body language, facial expression, gesture,

*Joint Unit for Planning Research, University College, London.
all convey how people feel about what they are saying, and how they feel, or want to appear to feel, about those to whom they are speaking. The motion image is required to transmit most nonverbal communication; far less can be put across through the use of still pictures alone, and without the visual element the most important nonverbal means are lost. Tone of voice, verbal emphasis, and the nonverbal utterances will remain if good quality voice audio is used.

In face-to-face communication the handshake, the smile, the first name, the ability to recognize and be recognized by someone to whom you have previously been introduced, can smooth communication whatever the objectives of the meeting may be. With interactive television all this except the handshake is possible and, if utilized, can make this medium very nearly as effective as a small-group, face-to-face meeting.

The Importance of Informality

The key to making the most of the interpersonal opportunity is informality. MRC's initial tendency, since changed, was to operate the system in the formal, presentational style of most broadcast television. This was the natural model for MRC personnel because they had no previous experience with closed-circuit television. This influenced the planned operation of MRC-TV from the program schedule to the "directing" of the transmissions.

Even the semantics of MRC supported the model: broadcasting words such as television network, program, show, studio, director, producer, and performer were in constant use. Under strong Rand recommendation these words were slowly replaced with a new vocabulary that included meeting, coordinator, participant, and the like. A few show business words persisted, such as studio and program, but these acquired their own connotations specific to MRC use. "MRC-TV" was also deplored but was far too simple and practical to be replaced by any other term.

At first the meetings were introduced almost like television programs. Before a meeting started an identification slide carrying
the MRC-TV letters against a photographic background of the World Trade Center was transmitted to the accompaniment of appropriate opening music, at least in the early experimental days. While the music was an early casualty, along with a production assistant who had been trained in television production, the slide was harder to eliminate. Finally it was argued that participants gathering in county studios need to see persons gathering also at WTC, just as they would if all were meeting together in the same place. This would assure them that the meeting is about to begin, about how close it may be to starting and begin to give them the feeling of sharing contact with another place. Accordingly, a wide shot of the WTC studio replaced the formal slide, accompanied by normal room sounds or the voice of the WTC controller helping various county operators adjust and check out their equipment.

Then Rand recommended that as much of the technical adjustment as possible be accomplished before the participants begin to gather for the meeting, so the last 10 or 15 minutes before a scheduled program can be devoted to informal greeting and other interaction between WTC and each county, and between county and county. It was suggested that this period be taken very seriously as a time of intense activity on the part of both the WTC controller and the meeting chairman. Actual personal introductions of individuals who have never met can be performed at this time, when it is possible to put the two persons together on a split screen. The degree of person-to-person contact here is far more intimate than the more formal introduction of an individual to a group or to a television audience. This introduction capability has not been fully realized on MRC-TV because there is no private open phone line interconnecting the WTC controller with all county operators so that split screens can be easily and quickly effected.

*Flexibility*

Because the problem of designing a teleconferencing system to provide audio-video communication between ten simultaneous locations was largely new, no one was sure how it should be solved. The designer's
original concept of participation on a formal basis with audio and video switched together was found unworkable because first words were being cut off and overlapping words or interruptions were lost. Luckily, the system could be easily revised. The same applies to the WTC chairman's need to preview various local sites and see those to whom he is speaking.

When final design needs cannot be confidently specified (and who knows exactly what a system may be called upon to do?), flexibility is a prime requirement. Options should be open, both in methods of procedure and in system design. System users (participants in the case of MRC-TV) cannot be expected to conform to the constraints of a system design, it must conform to them. Further, they cannot be expected to remain static in their procedures or modes of use. The system must be flexible in design and function to adapt itself to changing needs.

In teleconferencing it would seem that the best system is the one that is the most transparent and unnoticeable to its user. The more a participant can speak, hear, see, and otherwise interact, using the same behavior he has perfected for social interaction in the face-to-face mode, the more comfortable he will be. The more comfortable and natural he feels, whether he is giving a formal talk, teaching, engaging in informal conversation, or merely watching and listening, the more like face-to-face communication his experience with teleconferencing will be.

One day recently at MRC-TV, we observed two very effective meetings, both highly interactive, with exchange between counties as well as with WTC. All participants were active and interested, and those who took part at WTC expressed their pleasure at how much was accomplished and how effective the system seemed to be. In retrospect, we realized that no one who was using the system that day, whether speaker or participant, had had any prior experience with the system or, for that matter, probably with the television medium. (By coincidence, for one of these meetings the WTC console operator was a 16-year-old boy who was operating it for the first time, but of course he was not new to the system, he had been assisting for weeks.)
The point is that a communication system for intergovernmental service must be easy and convenient to use on an individual's first experience with it. The MRC-TV system, imperfect as it still is, passes this test admirably. It would appear, therefore, that the MRC-TV system as designed and as modified in practice is proving effective for the kinds of things it is now being called upon to do.
VII. SYSTEM COST

by Lawrence A. Dougharty

INTRODUCTION

This section develops a simple cost model that will aid communication system planners in estimating the cost of replicating a system such as MRC-TV in their own area. It is unlikely that the requirements of another area will demand a system identical to MRC-TV; therefore, in the model presented here, we attempt to break the costs down by system components so that planners can estimate the cost of a system designed to their specifications. Specifically, the model allows the planner to vary the number of sites, the amount of original program time (hours per month), and the type of programming (teleconferencing, instruction). "Sites," in this discussion, should be understood to mean points of origination/reception, not relay points. Points of reception only are known as one-way sites.

Two factors make the model's costs subject to great uncertainty.

1. System output. It is not practical to define system output precisely. For example, instructional programming costs will vary with each subject, depending on its difficulty, how expensive the instructor is, the amount of teaching assistance needed at the remote sites, and the amount of teaching material needed. Therefore, programming the model to estimate the cost of many courses would greatly enlarge it without correspondingly increasing its usefulness.

2. Only one data point. We based the model on only one observation. Many estimates of how component costs would be affected by changes in the scale of operation have necessarily been based on the subjective judgment of those who designed or operated the MRC-TV system, i.e., equipment contractor personnel (Genesys) and MRC personnel. To be sure, such estimating procedures are more uncertain than
those based on more experiences. Without such experiences, we attempted, wherever possible, to validate our estimates by comparing component costs with similar components in other systems.

One example of cost uncertainty is the price level. Price levels in New York are not typical of many other areas. To help counteract the problem of using New York as our single point data base, we have designed the model to estimate in terms of resource requirements as well as their cost. This allows the system planner to use resource prices available in his area. The model contains a set of reasonable prices (not necessarily the prices encountered by MRC in all cases) to approximate total system cost. But the planner is advised that price variations in his area may invalidate the total cost estimates. By substituting local prices, however, the planner can estimate the cost for his area.

An important caveat is that these cost estimates do not necessarily correspond to an increment in the budget that would be necessary to implement the two-way television system. Interactive television may be a more efficient method of doing some tasks, and hence act in some ways to reduce the budget. Assume, for example, that a local government sponsors training programs at multiple sites. With interactive television, the use of instructors at each site is eliminated: only one instructor is required, with teaching assistants at each site. If the training budget is used to support the television system, the incremental cost of implementing and operating the system will be smaller than the total system cost estimated here. The incremental cost will be a function of the present scope of activities in training and conferencing in the region. Since there is no practical way to anticipate a potential system's level of activity, we have not attempted to estimate the incremental resources that it may need. Though the model will be useful in estimating budget impacts, they cannot be estimated without a review of current government activities.

Table 7 shows the structural framework for the cost/resource model, with the cost components classified into investment and operating costs.
Table 7

COST ANALYSIS FRAMEWORK FOR INTERACTIVE
TELEVISION SYSTEM

<table>
<thead>
<tr>
<th>Variable Name</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Investment Cost</strong></td>
<td></td>
</tr>
<tr>
<td>I(3)</td>
<td>Preplanning</td>
</tr>
<tr>
<td>I(1)</td>
<td>Survey of Governments</td>
</tr>
<tr>
<td>I(2)</td>
<td>Preliminary Engineering</td>
</tr>
<tr>
<td>I(4)</td>
<td>System Engineering and Design</td>
</tr>
<tr>
<td>I(9)</td>
<td>Equipment</td>
</tr>
<tr>
<td>I(5)</td>
<td>Central</td>
</tr>
<tr>
<td>I(6)</td>
<td>County</td>
</tr>
<tr>
<td>I(7)</td>
<td>One-way Sites</td>
</tr>
<tr>
<td>I(8)</td>
<td>Relays</td>
</tr>
<tr>
<td>I(10)</td>
<td>Installation</td>
</tr>
<tr>
<td>I(11)</td>
<td>Debugging</td>
</tr>
<tr>
<td>I(12)</td>
<td>Facilities Remodeling</td>
</tr>
<tr>
<td>I(13)</td>
<td>Program Preparation and Staff Training</td>
</tr>
<tr>
<td>I(14)</td>
<td>Contractor Profit</td>
</tr>
<tr>
<td>I(18)</td>
<td>Miscellaneous</td>
</tr>
<tr>
<td>I(15)</td>
<td>Spare Parts Inventory</td>
</tr>
<tr>
<td>I(16)</td>
<td>Video Tape Inventory</td>
</tr>
<tr>
<td>I(17)</td>
<td>Maintenance Truck</td>
</tr>
<tr>
<td>I(19)</td>
<td>Total Investment Cost</td>
</tr>
<tr>
<td>I(20)</td>
<td>Total Equipment Contractor Cost</td>
</tr>
</tbody>
</table>

| **Annual Operating Cost** | |
| A(1) | Teleconferencing Programming |
| A(5) | Instructional Programming |
| A(2) | Coordinator |
| A(3) | Instructors |
| A(4) | Site-Coo. |
| A(9) | Program Distribution |
| A(6) | Comm. Dir. |
| A(8) | Signal Line |
| A(13) | Maintenance and Repair |
| A(10) | Personnel |
| A(11) | Parts |
| A(12) | Travel |
| A(14) | Tower Rental |
| A(15) | Training |
| A(16) | Annual Operating Cost |
Investment costs are incurred once only before the system is operational. Operating costs are incurred annually.

The description of the model is presented in three parts: a discussion of the cost/resource estimating relationships for the investment components, the development of the model for annual operating costs, and an illustration showing how these components can be put together to arrive at total system cost estimates.

**INVESTMENT COSTS**

The elements of each investment cost component are described below: what activities or equipment it includes, an estimate of its cost, and a discussion of the source and validity of that estimate.

**Preplanning**

This category includes the costs of studies dealing with the need for the system; the costs of coordinating the interests of the participating governments; and the costs of collecting information on the geographical location of each site, availability of microwave channels, and the topography of the region.

The resources required to survey local needs and obtain agreements from the participating governments will depend heavily on the degree of interaction that already exists within a region. MRC existed before the television system was introduced. Knowledge of the local political environment should have expedited this preplanning phase. MRC encountered special problems, however, because the jurisdictions involved were located in three different states. Based on the MRC experience, a reasonable estimate for a ten-site system (each site representing a different jurisdiction) would be about 18 man-months of effort. The marginal resource requirement for more or less sites would be approximately 1.5 man-months.

Associated with the direct salary costs of preplanning are overhead costs necessary to support the staff. These include such items as secretarial and clerical support, office rent, general and administrative expenses, and fringe benefits. We estimate these costs as a fraction of the direct salary expenses. The overhead
rate, $R$, is discussed more fully under annual operating costs. In mathematical form, the cost of the preplanning element becomes

$$I(1) = (3 + 1.5 \cdot s) W_p \cdot (1 + R),$$

where $I(1)$ = cost of study to survey needs and cost of obtaining agreements with participating governments

$s$ = number of sites

$W_p$ = average salary of professional personnel

$R$ = overhead rate as a fraction of direct salary cost.

The preplanning stage requires preliminary engineering and path surveys to insure that frequencies are available for local government use. MRC did a great deal of preparatory work before beginning the actual system design. It contracted with a consultant to do a feasibility study of interconnecting 17 MRC counties for a microwave TV system providing teleconferencing. He concluded that a microwave system was feasible and that sufficient channels were available for use.* This preliminary engineering study cost $20,000. We assume that each new area will require this type of study, so we relate this cost to the number of potential sites in the system. The cost of a path survey for each site would be approximately $500.** If a 17-site system cost $20,000, the generalized cost estimating equation is

$$I(2) = 11,500 + 500 \cdot s,$$

---

* MRC had already studied the use of telephone lines for television transmission. They concluded that dedicated phone lines for television transmission would cost some $800,000 a year. Further, if the system were dropped before a period of 10 years, a $750,000 penalty would be charged. These high costs ruled out the use of telephone company facilities.

** This estimate includes the cost of obtaining a certificate of performance from the Federal Communications Commission.
where \( I(2) \) = cost of path surveys
s = number of sites.

System Engineering and Design

System engineering and design includes such items as system layout (e.g., where to locate relay stations, and their antenna size), and equipment specification. The MRC system design required some 2500 hours (14.2 months) of engineering -- 2000 for electrical engineering and 500 for mechanical engineering. This does not include engineering time for installing or debugging the system. Genesys personnel maintain that there would be no reduction in the amount of engineering required for an installation in another area. In essence, all the engineering costs are site specific. The marginal resource requirement for engineering time for more or fewer sites was estimated to be 0.5 man-months. Based on the MRC experience, then (12 sites at 14.2 months), the estimating relationship for system engineering and design would be

\[
I(4) = (8.0 + .5(s + r)) \cdot E,
\]

where \( I(4) \) = engineering and design cost
E = cost per engineering month
s = number of county sites
r = number of relay sites.

Genesys average charge for an engineering month is $4000, which includes all burden, travel, and general and administrative expenses.*

Equipment Design

The system uses only stock items, so no equipment design cost is necessary.

*At this writing, $25 for a senior engineering hour and $20 for a junior engineering hour are good rules of thumb.
Equipment

Genesys estimated equipment costs for the rf capability (receiving and transmitting signals) and the studios in their original proposal to MRC. Genesys stated that these costs turned out to be low by some 15 percent for the following reasons: in some cases the equipment actually installed was better than that specified in the original proposal, the original proposal did not itemize all equipment, and some prices rose during the construction period. Using the Genesys estimates and increasing them by 15 percent, the following estimates for the equipment cost are obtained:

Central Site

rf equipment ............. $58,600
Studio ................... 34,000

County Facility

rf equipment ............. $19,550
Studio ................... 8,940

The estimating relationships for equipment costs at the central and county sites are:

I(5) = central site equipment cost = $92,600
I(6) = total county site equipment cost = $28,495 . s.

The original Genesys estimates included an omni antenna for each county site.* This antenna is used only for transmitting to one-way stations, and therefore its cost (approximately $3000) should be allocated to a one-way station rather than to a county facility. Genesys personnel estimated that each one-way location would cost approximately $2000 including engineering and installation. The total one-way station cost (including omni antennas at the county facility) would be

*This cost is not included in our estimate of county facility costs.
\[ I(7) = \sum_{i=1}^{s} [3000 \cdot a(i) + 2000 \cdot n(i)], \]

where \( I(7) = \) equipment cost for one-way sites
\( a(i) = 1 \) if \( n(i) > 0 \), 0 otherwise
\( n(i) = \) number of one-way stations in the \( i^{th} \) county.

Relay stations must be able to receive and transmit signals to and from both the central facility and the two-way site at the county. According to Genesys personnel, a reasonable cost analog for the relay station would be two county rf systems. Using this analog the cost of a relay station is

\[ I(8) = \text{relay station cost} = 39,900 \cdot r, \]

where \( r = \) number of relay stations in the system.

The total equipment cost is the sum of the costs for the central facility, county sites, one-way sites, and relays:

\[ I(9) = \text{total equipment cost} = I(5) + I(6) + I(7) + I(8). \]

**Equipment Installation**

Equipment installation costs can vary widely depending upon the circumstances at each site. If county sites require tall towers, for example, the installation costs will be greater than if the antenna can be attached easily to an accessible superstructure on the building. Installation of central facility equipment at the World Trade Center is probably not typical of installation in other areas because of the labor union problems that were involved.

Genesys personnel estimated that installation at the county sites and relay stations would require two men for one week of engineering and supervision. In the case of MRC, additional subcontract labor was necessary for such work as climbing towers and piloting helicopters. Subcontracting costs averaged $1000 per site.
Installation at the central facility will be more time-consuming, requiring 2 man-months of engineering and supervision. An additional $30,000 in subcontract items was necessary to cover such expenses as having the antennas raised to the roof and installed. Based on these estimates, the following estimating relationship for installation costs can be derived.

\[
I(10) = 30,000 + 2 \cdot E + (.5 \cdot E + 1000) \cdot (s + r)
\]

\(I(10) = \) installation cost

where \(E = \) cost of engineering month
\(s = \) number of county sites
\(r = \) number of relay sites.

The installation cost of one-way facilities is included in their equipment cost.

**Debugging**

A system as complex and innovative as MRC-TV required about 1-man-month of full checkout and debugging service supplied by Genesys. (The services of the communications director and the system maintenance person were also used, but these costs are included in the initial training cost category.) This cost is fairly insensitive to the number of sites. For preliminary estimating purposes debugging can be considered to involve

\[
I(11) = \text{cost of debugging} = E
\]

\(E = \) cost of one engineering month.

We assume that any debugging cost at a one-way facility is included in the equipment cost.

**Facility Remodeling**

Some facility remodeling may be necessary to make existing space acceptable for television broadcasting. The central MRC facility
required approximately $30,000 to remodel. Of this amount an estimated $20,000 was used to alter the roof to accept the antennas. Since we have no way of determining what special circumstances necessitated this charge (weather, peculiarities in the design of the World Trade Center, etc.), we assume that this cost will be encountered in other areas. Studio alterations cost $10,000. Actually this cost was the charge to MRC for excess wall space and electrical outlets over that given free to tenants in the World Trade Center. Facility remodeling costs will vary depending upon the extent of changes needed in the existing structure. The $10,000 figure seems reasonable for typical remodeling efforts and we use it here.

County studios should be sound deadened. This merely requires drapes and carpets although many counties in the MRC system have not installed these items yet. Such costs are estimated at $1000 per site.

The total cost of facility remodeling is then estimated as

\[ I(12) = 30,000 + 1000 \cdot s \]

\[ I(12) = \text{cost of facility remodeling} \]

\[ s = \text{number of county sites}. \]

Program Development and Staff Training

Before two-way television transmission begins, a great deal of preparatory work must be completed. The following describes a nominal effort in program preparation and training.

1 Director of Communications -- 6 months

The director of communications is responsible for operating the system. He should be made part of the team that installs and debugs the system in order to enhance his understanding of how the system operates. A four-month lead-in period and two months for trial operation and debugging should be adequate for training purposes.
1 System Maintenance Person -- 6 months

For the same reasons as given for the director of communications, at least one maintenance person needs to familiarize himself with the system. During the six-month period, this individual is not only learning but providing useful services in installing and debugging the system. It would be more accurate to allocate his time among various activities, but such accuracy is not required for making preliminary cost estimates.

1 Planning Director -- 6 months

This person will oversee relationships with the engineering contractor and the participating governments. He will also have overall responsibility for program planning.

1 Conference Development Coordinator -- 6 months

A conference development coordinator will be responsible during this period for assessing program needs, organizing meeting groups, and planning special conferences. The number of coordinators that will be needed depends upon the number of fields in which teleconferencing will be undertaken. MRC, for example, had one individual work full-time on developing conferences in the field of law enforcement. Having one individual develop lists of officials in many areas and perhaps developing conferences in a few areas or on topics of current interest appears to be a small but efficient beginning.

1 Instructional Course Development Coordinator -- 6 months

This person would be responsible for surveying the
participating governments on their training needs. He would also structure the course content and select faculty and other training media.

1 Communications Consultant -- 3 months

Most of the staff will need training in how best to use interactive television in both its training and conferencing role. It is suggested that a consultant be used in the start-up period to help develop operating and utilizing techniques for use on the new system.

The total professional personnel time required would be 24 months of program personnel and 6 months of technical personnel. Using a $150 daily rate for a consultant, his total cost would be $10,000. The estimating relationship for program preparation and staff training including overhead, would then be

\[ I(13) = (10,000 + 24 W_p + 6 W_t)(1 + R), \]

where \( I(13) \) = cost of program preparation and staff training
\( W_p \) = average monthly salary of government professional personnel
\( W_t \) = average monthly salary of technical personnel.

Contractor Profit

Genesys stated that their profit rate was typically 10 percent of the equipment price. MRC did not receive any competitive offers to check the price of the system. The two other firms that did submit bids really wanted to provide the hardware, but not system integration. Since the profit will not be a large part of the total system cost, we can use the Genesys estimate of the profit rate without admitting large errors into the model.

\[ I(15) = pI(9), \]
where $I(15) =$ contractor profit
$p =$ contractor profit as a percentage of equipment cost
$I(9) =$ equipment cost.

Miscellaneous

Several small purchases will also be necessary in the investment period to get the system operational. For instance, a spare parts inventory must be created. Genesys stated that they have $5000 worth of spare parts inventory for the MRC system. Since most of the parts can be obtained on 24-hour notice in the New York area, this inventory is very small as a percentage of original equipment cost.* We assume that this inventory is proportional to the number of sites including the central facility. Since MRC has 12 operating sites (WTC, county sites, and relay stations), we have

$$I(15) = \frac{5000}{12} (s + r + 1)$$
$$I(15) = \text{cost of initial spare parts inventory}.$$

If videotape will be used extensively, such costs can become quite high and should be considered in system estimates. The amount of tape used depends upon (1) the number of hours of programming and (2) the length of time each program will be stored on tape. In mathematical form, the estimating relationship is

$$I(16) = (2 \cdot T \cdot M_t + H \cdot M_c)V,$$

where $I(16) =$ cost of videotape inventory
$T =$ number of monthly teleconferences
$M_t =$ average number of months that conference tape is saved
$H =$ number of instructional course hours per month

*Areas that are not close to major outlets for electronic equipment may need a larger inventory, so the estimate presented here should be increased.
\[ M_c = \text{number of months that course tape is saved} \]
\[ V = \text{price of one hour of videotape}. \]

The system will also require a truck for the maintenance person. A panel truck should cost approximately $4500. One truck should be sufficient for any reasonable size system considered here (less than 20 sites spaced at distances similar to those in the MRC system).

\[ I(17) = 4500 \]
\[ I(17) = \text{investment cost of maintenance vehicle}. \]

The miscellaneous investment cost is then

\[ I(18) = I(15) + I(16) + I(17), \]

where
\[ I(18) = \text{miscellaneous investment cost} \]
\[ I(15) = \text{cost of initial spare parts inventory} \]
\[ I(16) = \text{cost of video tape inventory} \]
\[ I(17) = \text{investment cost of maintenance vehicle}. \]

**Total Investment Cost**

The total investment cost is the sum of the various cost components.

\[ I(19) = I(3) + I(4) + I(9) + I(10) + I(11) + I(12) + I(13) + I(14) + I(18), \]

where
\[ I(19) = \text{total investment cost} \]
\[ I(3) = \text{preplanning} \]
\[ I(4) = \text{system engineering and design} \]
\[ I(9) = \text{equipment} \]
\[ I(10) = \text{installation} \]
\[ I(11) = \text{debugging} \]
\[ I(12) = \text{facilities remodeling} \]
\[ I(13) = \text{program preparation and staff training} \]
I(14) = contractor profit
I(18) = miscellaneous.

Total Contractor Cost

The total investment costs are likely to be much larger than the annual operating costs. To pay for the investment costs, the participating governments could sell bonds, pay for the system out of the operating budget, or work out an agreement to lease the equipment. MRC has chosen the last option. In effect, they are spreading the equipment contractor costs over a ten-year period. This enables them to finance the system without having to ask the participating governments for a large, one-time payment. Later we estimate what the annual costs will be if the contractor costs can be amortized over a ten-year period. Doing this requires an estimate of the equipment contractor costs. The estimating relationship for these costs is simply the sum of the estimates of the cost components that are the responsibility of the equipment contractor:

\[
I(20) = I(4) + I(9) + I(10) + I(11) + I(14),
\]

where
\[
I(20) = \text{equipment contractor cost}
I(9) = \text{equipment}
I(10) = \text{installation}
I(11) = \text{debugging}
I(14) = \text{profit}.
\]

Annual Operating Costs

Annual operating costs represent resource expenses.* This section of the report presents estimates of annual operating costs as a function of the amount of original live programming and the number of remote sites -- the prime determinants of the level of operating costs.

* The distinction between investment and operating costs is not always a clear one, as discussed later.
Programming Costs

Program costs are those incurred in preparing programs for airing. MRC presents two types of television programming -- teleconferencing and instruction.

Teleconferencing. Teleconferencing involves local officials discussing issues of concern among themselves and with invited experts. MRC has been presenting two types of teleconferences: periodic meetings of special groups of government officials -- e.g., personnel officers and elected officials; and current issues of wider interest to local agencies. For example, in January of 1974, MRC produced a teleconference on the energy crisis that allowed local agencies to interact with officials from the Federal Energy Office. In February, Roy Ash, Director of the Office of Management and Budget, discussed the implications of the new Federal budget with the audience at the county sites.

At present, MRC devotes about 2.25 man-years annually to developing and coordinating teleconferences. With this level of effort, it presented eight teleconferences in January. In October 1973, when MRC had another individual on the staff, they were able to present eleven teleconferences. This indicates that the number of teleconferences is a linear function of the amount of manpower devoted to their production. The personnel requirement for each teleconference would be 0.28 man-months (2.25 man-months/8 teleconferences). The estimating relationship in the model for the cost of teleconferencing, including overhead, is

\[ A(1) = (0.28 \cdot T \cdot 12 \cdot W_p) \cdot (1 + R), \]

where \( A(1) \) = annual cost of teleconferencing programs

\[ T = \text{teleconferences per month} \]

\[ W_p = \text{average salary of professional personnel}. \]

It should be noted that the largest cost of these conferences is the time of the officials participating. Although we are not including this cost in the model, it should be considered when teleconferencing is evaluated as an effective alternative for providing officials with
information. Comparisons of alternative ways of providing such information is not an objective of this phase of the research. Our immediate objective is to estimate the cost to implement and operate an interactive television system.

Instruction. The MRC system is also being used to provide training for participants at the county sites. Courses have been given in speedwriting, effective writing for administrators, and management and supervision. The basic resources involved in preparing the instructional program are an instruction coordinator at the central facility, and course coordinators at each site.

MRC has one full time coordinator for its instruction program. In January 1974, it aired nine hours of live training programs. The demands on the coordinator's time, however, are not generated solely by the number of programming hours. His workload is also a function of the number of courses (two one-hour courses require more effort than one two-hour course); the type of course material (training in simple skills seems to require less of his administrative attention than a course dealing with more complex subjects); the amount of visual material he must prepare; and the number of times the course has been given previously.

Much of the information needed to estimate the amount of coordination accurately will not be available in the early stage of planning an interactive television system. We have therefore simplified the estimating procedure. MRC's instruction coordinator believes that at the maximum he could handle 20 hours a month of live programming. This assumes that new courses are integrated slowly into the programming rather than coming in bunches so that the course development effort is not required all at once. We further assume that the amount of coordination is linearly related to the number of live class hours (i.e., one class hour generates the requirement for 0.05 of a man-month). Coordination expenses at the central site, including overhead, would be represented by

\[ A(2) = (0.05 \cdot H \cdot W_p \cdot 12) \cdot (1 + R), \]
where $A(2) = \text{annual coordination cost at central facility}$

$H = \text{hours of live instruction per month}$

$W_p = \text{average monthly salary of professional personnel.}$

We estimate the cost of instructors at $50$ per hour. Since most
of the courses given at MRC last two hours, this would mean a daily
rate of $100$ per instructor. The exact amount paid will depend upon
the nature and length of the course, but the $100$ estimate should
cover the cost of instructors for a program such as the one sponsored
by the MRC.*

$$A(3) = C \cdot H \cdot 12,$$

where $A(3) = \text{annual cost of instructors}$

$C = \text{hourly cost of instructors}$

$H = \text{hours of live instruction per month.}$

In the MRC system, each site has a course coordinator who organ-
izes the sessions at the site and provides feedback to the instructional
 coordinator at the central site about problems in course design and
implementation. This effort requires approximately one hour of out-
of-class preparation for each hour of instruction. In addition, one
extra hour of the site coordinator's time for each teaching hour would
be needed for each one-way station. The estimating relationship then
is

$$A(4) = 12[2 \cdot H \cdot G_p \cdot S + H \cdot G_p \cdot \sum_{i=1}^{s} n(i)]$$

where $A(4) = \text{annual cost of site coordinators}$

$H = \text{number of original hours of instruction per month}$

$G_p = \text{hourly cost of site coordinators, including direct}
\text{support and fringe benefits}$

*At this point MRC has not paid the instructors directly. The
instructors are all volunteers from participating governments.
s = number of sites
n(i) = number of one-way sites in the ith county.

MRC also experienced some cost in producing visual aids for the classes. This work was performed by the support staff. Since the cost was small, we include it in overhead rather than making it a separate estimating category. In more sophisticated production, of course, it could amount to a sizable item.

The total cost of instruction would be the sum of the three components:

\[ A(5) = \text{cost of instruction} = A(1) + A(3) + A(4). \]

MRC video tapes all of the training sessions. These tapes can then be reshown whenever there is a demand from a county site. Presently there is a large amount of time when no programs are scheduled so that reruns can easily be accommodated. We are assuming that the cost of running the tapes is negligible. The major assumption here is that the lecturer does not charge on the basis of the number of showings. The model will only estimate the cost of live instructional hours. The communications system planner must alter the estimate when he intends to use video tape replays extensively.

Program Distribution Costs

Program distribution costs are incurred in program transmission and reception. At present, the MRC system employs the following personnel for program distribution:

- one communications director at the central facility -- full time
- one part-time county operator at each site.

The communications director must prepare the studio and operate during the program (controlling cameras, correcting problems in technical clarity, initiating split screens, and switching between county
sites). MRC is broadcasting approximately 30 hours per month. Any additional broadcasting would require additional operators, and we assume that each additional 30 hours would require another operating technician. We do not reduce the cost of the communications director for under 30 hours of operations per month because a full-time communications director is required almost regardless of the number of hours of programming. The cost of personnel (including overhead at the central facility) for distribution is then

\[ A(6) = 12W_p \cdot (1 + R) \quad \text{if } 2T + H \leq 30 \]

\[ = (12W_p + \frac{(2T+H-30)}{30}) \cdot 12W_t \cdot (1 + R) \quad \text{if } 2T + H > 30, \]

where \( T \) = number of teleconferences (since the average length of a teleconference is two hours, the number of hours devoted to teleconferencing is \( 2T \))

\( W_p \) = monthly salary of professional personnel

\( W_t \) = monthly salary of technicians.

The operators at the county sites are typically clerical personnel who are trained to turn the equipment off and on and to make minor equipment adjustments to increase the technical quality of the picture. Some operators merely turn the equipment on and off and leave the room during the program. The preferred operation is to have the operators in the room at all times. In our cost estimates we will assume that the operators are at the console throughout all meetings and also called upon to warm up the equipment before a program and to operate the equipment when the central facility wants to check on picture quality from the site. We have estimated that the operators spend an additional quarter hour for each hour of programming on these tasks.* The cost of operators is

*Since each program is usually two hours long, we are assuming a half hour warm-up period.
A(7) = 1.25(2T + H) 12 \cdot G_c \cdot s,

where A(7) = annual cost of operators at county sites
s = number of county sites
G_c = hourly cost of clerical personnel in county government
      including direct support and fringe benefits
T = number of teleconferences per month
H = number of original instructional hours per month.

We assume no costs are involved in receiving the picture at one-
way facilities. Someone in the audience will be responsible for turn-
ing the television monitor off and on.

Another distribution cost is the telephone signal lines that are
used to allow the county facilities to signal the central facility that
they wish to speak. These dedicated lines cost approximately $20 per
site per month.

A(8) = annual cost of signal lines = 12 \cdot 20 \cdot S.

The total distribution cost is

A(9) = A(6) + A(7) + A(8)
A(9) = annual cost of program distribution.

Maintenance and Repair

The MRC system currently has one full-time maintenance person and
subcontracts out special maintenance tasks such as the FCC frequency
check and maintenance that requires tower climbers. The amount of
maintenance personnel time required will depend on such things as the
amount of time that one is willing to have a site down, transportation
time between sites, the number of sites, the amount of unscheduled time
(i.e., time to use the system for maintenance), and the reliability of
system components.

A major determinant of the amount of maintenance personnel time
required is the number of sites. Using the MRC system as an analog,
we estimate that two maintenance persons are needed for a ten-site system (county facilities and relays) and one person for a five-site system. Assuming linearity (one-fifth of a maintenance man per site), we have

\[ A(10) = 12 \cdot W_t \cdot s/5, \]

where \( A(10) \) = annual cost of maintenance personnel.

MRC's equipment repairs average $50 per month, or approximately $1.67 per operating hour. Genesys expects to replace the large transmitter tubes and some camera tubes over the life of the system. These parts should increase the cost by about another $1 per hour. The total cost of repair parts is then expected to be approximately $2.67 per hour.

\[ A(11) = 2.67 \cdot 12 \cdot (2T + H) \]

where \( A(11) \) = annual cost of replacement parts

\[ T \] = number of teleconferences per month

\[ H \] = number of original instructional hours per month.

Maintaining the system will involve travel costs for the maintenance men. We have already included the purchase of a vehicle under investment costs. The operating costs are estimated to be 15 cents per mile. If the average distance from the central facility to a county facility is 35 miles, and if each site is visited 1.5 times per month, then the total mileage per month will be 105 miles per site. * The estimating relationship for maintenance would be

\[ A(12) = 12 \cdot 105 \cdot 15 \cdot (s+r) = 189(s+r), \]

where \( A(12) \) = annual cost of maintenance related travel

\[ s \] = number of county sites

*We assume that the additional travel cost to service any one-way facility is negligible.
\[ r = \text{number of relay stations.} \]

The total cost of maintenance and repair is then

\[ A(13) = \text{annual cost of maintenance and repair} = A(10) + A(11) + A(12). \]

**Facilities Rent**

The MRC system, with its central facility in Manhattan, pays a high price for its office space, and similar costs are not likely to be incurred in most other areas. It seems likely that governments will try to use their own existing space. Therefore, we have not incorporated rent for office space in this model, but we have incorporated it into our estimate of overhead costs. Since most governments have a better idea of their overhead rate than they do of space charges in government-owned buildings, this method of accounting for rent should make the model more useful. When government space is not available, it should be an easy matter to get estimates of rent from private building owners, which can then be added to the costs estimated by the model with an appropriate reduction in overhead charges, of course.

To make this estimate, however, it is necessary to know how much space is needed. MRC has some 5000 square feet, presently more than enough space. Approximately 1600 square feet are used for the studio and the control room. Space required over this amount for programming and administrative staff is a function of the amount of programming that will be undertaken. MRC's service level of 30 hours per month seems to require 2400 feet of office space. We would assume that the demand for space is linearly related to hours of programming. We believe this to be a rough approximation, though perhaps some economies of scale could be achieved as programming increases well beyond 30 hours.

The county facilities all had space available for the system. Our assumption will be that all county sites would have a room (approximately 20 feet by 20 feet) available to serve or double as a studio. Many MRC-TV county studios are conference rooms; one is a law library.

\* This assumes a zero opportunity cost for such excess space.
The communications system planner should check on the availability of excess space to be sure that the model will actually reflect local conditions.

MRC must also pay $4000 yearly to use the roof at the World Trade Center. Since tall buildings in metropolitan areas are typically privately owned, we have incorporated this cost into the model. An alternative in some areas may be to use a nearby mountain top. In this case, facilities will have to be constructed at the site. The annualized charge of these facilities would probably be about $4000. If an existing transmitting site is available to a locality, this cost should be eliminated:

\[ A(14) = \text{annual cost of space for central facility tower} - \$4000. \]

Training

The initial training given staff members before the system becomes operational is crucial to the success of two-way television. Technical difficulties can make viewers in remote sites dissatisfied with the system's performance. Further, if effective ways of presenting material are not learned, two-way television will not be used to its full advantage. The importance of training makes the personnel who started with the system extremely valuable. Staff turnover then could degrade system performance or cause high annual training costs. Moreover, there may be some need for in-service training so that staff personnel learn about more effective ways to use two-way television.

MRC has experienced a large staff turnover (a total of 11 staff positions have been filled by 22 persons in the year and one half since the signing of the initial contract with Genesys in September 1972). Fortunately for MRC, none of the key people have changed. This turnover occurred principally because it was not known at the start what type of training and experience would be best to fill the various positions. Hiring was done on a somewhat experimental basis with a resulting high turnover. We assume that the long-run turnover rate will be about 20 percent annually. The average training period
for new employees will be approximately 1.5 months. Most of this training will be working with the individual who will be leaving so the principal expense will be salary cost. Under these assumptions the annual training cost is estimated to be

\[ A(15) = 0.20 \times \frac{1.5}{12} \times P = 0.025 \times P, \]

where \( P = \) annual personnel cost.*

Because this cost is small, even large errors in our assumption about turnover and average training period will not radically alter the system's operating costs.

Central Site Overhead

We have not estimated many central site costs separately (i.e., office space rental, direct support, general and administrative expenses, and fringe benefits). These can be quite large. In MRC's case they appear to be approximately 100 percent of direct salary costs. This relatively large overhead rate (as compared to many other government overhead rates) is due largely to the rent for privately owned office space ($36,000 per year at the World Trade Center); a large administrative cost to direct salary cost ratio (due principally to the small size of the central site operation that cannot capture many economies of scale); and a staff to support ratio (6:4) that is much higher than is typical in many governments.**

Other governments, of course, may have much lower overhead rates than MRC, and the communications system planner is advised to substitute the applicable rate in preparing his cost estimates.

Overhead costs of county personnel have been included in the estimates of the hourly charges for such personnel. These overhead

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* \( P = A(1) + A(2) + A(6) + A(10) \).

** The staff-support ratio has varied throughout MRC-TV's existence. (See Table 9.) We have based our estimate of 100 percent overhead rate on the average staff to support ratio.
costs should be small compared with those at the central facility. The tasks assigned to county personnel do not require the same level of support as those at the central facility. Further, the cost of office space should also be much less in government owned facilities.

Total Operating Cost

The total cost is the sum of the individual operating costs:

\[ A(16) = A(1) + A(5) + A(9) + A(13) + A(14) + A(15), \]

where

- A(1) = teleconferencing
- A(5) = instruction
- A(9) = program distribution
- A(13) = maintenance and repair
- A(14) = tower rental
- A(15) = training.

Total System Cost

To this point, we have detailed a method for estimating the total cost of acquiring and operating an interactive television system. Use of this method requires specification of the value of two types of variables -- price and policy, both shown in Table 7. The price variables are indicators of the prices that will be encountered in the region under study, including such factors as technician wages, overhead rates, and salaries of professional personnel. The policy variables are those that determine the system's shape and composition, including the number of county sites and the amount of instruction.

Table 8 shows the values for the price variables used in the model. These are not necessarily the prices encountered by MRC, because we felt that their experience may have been atypical, so we have substituted what we believe to be prices that other governments are more likely to encounter. Most of these prices are readily available to the planner in each area, so it will not necessitate much additional work to check the validity of these values.
<table>
<thead>
<tr>
<th>Variable Name</th>
<th>Definition</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Policy Variables</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>T</td>
<td>Number of teleconferences per month</td>
<td>a</td>
</tr>
<tr>
<td>H</td>
<td>Number of hours of original instruction per month</td>
<td>a</td>
</tr>
<tr>
<td>s</td>
<td>Number of county sites</td>
<td>a</td>
</tr>
<tr>
<td>n(i)</td>
<td>Number of one-way sites in i\textsuperscript{th} county</td>
<td>0</td>
</tr>
<tr>
<td>r</td>
<td>Number of relay stations</td>
<td>0</td>
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<td>M\textsubscript{t}</td>
<td>Average number of months that videotape of teleconference is saved</td>
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</tr>
<tr>
<td>M\textsubscript{c}</td>
<td>Average number of months that videotape of instructional course is saved</td>
<td>12</td>
</tr>
<tr>
<td><strong>Price Variables</strong></td>
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<tr>
<td>W\textsubscript{p}</td>
<td>Average monthly salary of professional personnel</td>
<td>$1500</td>
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<tr>
<td>E</td>
<td>Cost per engineering month</td>
<td>$4000</td>
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<tr>
<td>P</td>
<td>Contractor profit rate as a percentage of equipment cost</td>
<td>10%</td>
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<tr>
<td>G\textsubscript{p}</td>
<td>Hourly cost of county site course coordinators</td>
<td>$9</td>
</tr>
<tr>
<td>W\textsubscript{t}</td>
<td>Average monthly wage of technicians</td>
<td>$1200</td>
</tr>
<tr>
<td>G\textsubscript{c}</td>
<td>Average hourly cost of clerical personnel at county sites</td>
<td>$5</td>
</tr>
<tr>
<td>R</td>
<td>Government overhead rate as a percentage of direct salary cost</td>
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<tr>
<td>V</td>
<td>Cost of videotape per hour</td>
<td>$30</td>
</tr>
<tr>
<td>C</td>
<td>Hourly cost of instructors</td>
<td>$50</td>
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</tbody>
</table>

\textsuperscript{a}The value of these variables are varied in the sensitivity analysis presented here.
Some policy variable values will be altered to give an estimate of the sensitivity of system cost to changes in system design. These changes are basically of two types: changes in size as measured by the number of county sites, and changes in the number of hours of original programming.

Changes in the Number of Sites

One variable that will determine system cost is the number of county (i.e., two-way) sites in the system. The communications system planner must decide on how many sites to install and where each site should be located. The cost of each additional site will depend largely upon whether a relay station is necessary to transmit and receive signals from the central facility. If there is no "line of site" between the central facility and the county site, a relay station will be necessary. The MRC system, for example, uses two relay stations. In some cases tall towers at the county site can substitute for relay stations; however, these towers are expensive, and more important, are not very attractive and are likely to engender opposition from community residents. Table 9 shows the cost of a ten-site system that has no relay stations or one-way sites. These costs are in 1972 dollars.

Equipment is the largest investment component (approximately 50 percent -- $377,550). Operating costs are about $275,000 per year. The ten-year cost of the system will be $3.5 million.

The ten-year system costs for systems ranging from 5 to 15 sites are shown in Fig. 19. For five county sites the amount for investment and ten years of operation is $2.6 million. (System costs apparently are not too sensitive to the number of sites, since the cost of tripling the number of sites from 5 to 15 only raises the cost by approximately 65 percent -- $4.3 million.)

*Equipment prices have been rising at approximately 5 percent per year according to Genesys personnel. The planner should revise equipment costs upward to reflect inflation. The inflation in personnel costs is treated by substituting current local wages into the model.
Table 9

COST ESTIMATE FOR INTERACTIVE TELEVISION SYSTEM

Number of County Sites: 10  Number of One-Way Sites/County Site: 0
Teleconferences per Month: 8  Instructional Hours per Month: 14

Investment Cost

<table>
<thead>
<tr>
<th>Category</th>
<th>Cost</th>
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</thead>
<tbody>
<tr>
<td>Preplanning</td>
<td>70500</td>
</tr>
<tr>
<td>System Engineering and Design</td>
<td>52000</td>
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<tr>
<td>Equipment</td>
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<tr>
<td>Satellites</td>
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<tr>
<td>Relays</td>
<td>0</td>
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<tr>
<td>Central</td>
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<tr>
<td>County</td>
<td>284900</td>
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<tr>
<td>Installation</td>
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<tr>
<td>Debugging</td>
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<tr>
<td>Facilities Remodelling</td>
<td>40000</td>
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<tr>
<td>Program Prep. and Staff Train.</td>
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<tr>
<td>Contractor Profit</td>
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<tr>
<td>Miscellaneous</td>
<td>14600</td>
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<tr>
<td>Spares Inv.</td>
<td>4600</td>
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<tr>
<td>Maint. Veh.</td>
<td>4500</td>
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<tr>
<td>Tape Inv.</td>
<td>5500</td>
</tr>
<tr>
<td><strong>Total Investment Cost</strong></td>
<td><strong>760800</strong></td>
</tr>
</tbody>
</table>

Total Contractor Cost = 539305

Annual Operating Cost

<table>
<thead>
<tr>
<th>Category</th>
<th>Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Teleconferencing Programming</td>
<td>81000</td>
</tr>
<tr>
<td>Instructional Programming</td>
<td>63800</td>
</tr>
<tr>
<td>Coordinator</td>
<td>25200</td>
</tr>
<tr>
<td>Instructors</td>
<td>8400</td>
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<td>Site-Coord.</td>
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<td>Comm. Dir.</td>
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</tr>
<tr>
<td>Site Op.</td>
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<td>Signal Line</td>
<td>2400</td>
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<tr>
<td>Maintenance and Repair</td>
<td>61400</td>
</tr>
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<td>Personnel</td>
<td>57600</td>
</tr>
<tr>
<td>Parts</td>
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<td>Travel</td>
<td>2800</td>
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<tr>
<td>Tower Rental</td>
<td>4000</td>
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<tr>
<td>Training</td>
<td>2900</td>
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<tr>
<td><strong>Annual Operating Cost</strong></td>
<td><strong>274000</strong></td>
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</table>

Fig. 19--Ten year system costs
Another way of viewing expenses is to look at the cost that each county must bear. We assume that as in the case of MRC the engineering contractor costs (system engineering and design, equipment, installation, debugging, and contractor profit) can be annualized through a lease payment rather than being paid in the first year of operation. This means that the counties can finance the system without having to make a large one-time investment that would be difficult to finance. We will further assume that the contractor costs are capitalized at the rate of 10 percent. For example, the contractor costs for a 15-site system would be $733,300. To pay for these costs and interest over ten years, the yearly payment would be $119,400. The sum of the annualized contractor cost and operating costs for a 5-, 10-, and 15-site system are tabulated below:

<table>
<thead>
<tr>
<th>Number of Sites</th>
<th>Total Annualized Cost</th>
<th>Annual Cost per Site</th>
</tr>
</thead>
<tbody>
<tr>
<td>5</td>
<td>$274,300</td>
<td>$54,800</td>
</tr>
<tr>
<td>10</td>
<td>362,100</td>
<td>36,200</td>
</tr>
<tr>
<td>15</td>
<td>449,800</td>
<td>30,000</td>
</tr>
</tbody>
</table>

Other investment costs are around $200,000 for the range of systems considered here. Therefore, the expense to each county during construction would be lower than the annualized costs shown above that reflect full operation. Of course, the counties would be receiving no service during the construction period.

Changes in the Amount of Programming

MRC is presently programming about 30 hours of original telecasts per month. Since there are some 170 hours in a month available for programming,* it is obvious that the system could be used more intensively. Whether one would want to increase system utilization would

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*This assumes an 8-hour day. The system could also be used at night. Nighttime use would be practical for educational purposes, but probably not feasible for teleconferencing.
depend upon the demand for additional programming and the cost associated with that programming.

The estimate of demand for programming will require the communication systems planner to survey the information needs of the participating governments. The model presented here will allow the planner to make preliminary cost estimates for meeting various levels of demand. Table 10 shows the total system cost (investment plus 10-year operating cost) of a ten-site system for a range of programming hours -- between 30 hours (MRC) and 120 hours. The 120-hour figure is an approximate upper limit. This means that 2 hours a day are left unscheduled for such things as maintenance and programs that run over their allotted time.

The investment cost is not very sensitive to the amount of programming, being composed primarily of equipment costs that do not depend on the number of hours of programming. Therefore, estimates of the cost of alternative size systems (number of sites) can be made by adding a system's investment cost to the operating costs shown for the various programming levels.

Table 10 also shows the annualized cost. This is the ongoing cost per year when the amortized cost of the equipment contractor is added to the annual operating cost. The table also reflects the cost per site that would have to be paid to finance the system. These costs range from $36.2 thousand for 30 hours of programming monthly to $95.3 thousand for 120 hours of programming monthly.

Last, Table 10 shows the cost per site on an hourly basis. These figures may appear quite high on first examination. For a two-hour conference it seems that each site must pay $200 if the system operates 30 hours per month. Remember, however, that costs are only high or low in comparison with the alternative. If a conference were to be held by a conventional method, instead of by teleconferencing, planning cost would likely be the same. If this cost were removed from our estimate, the annualized cost per site of teleconferences would be reduced to $21.8 thousand or $60 per site per hour. Now let us say that each site had three people in attendance. By conventional means they would have to spend an hour each way (one
Table 10
COST ESTIMATE FOR VARIOUS PROGRAMMING LEVELS
(10-site system)

<table>
<thead>
<tr>
<th>Programming Level (hours/month)</th>
<th>Investment Cost $(000)</th>
<th>Ten-Year Operating Cost $(000)</th>
<th>Ten-Year System Cost $(000)</th>
<th>Annualized Cost $(000)</th>
<th>Annualized Cost per Site $(000)</th>
<th>Annualized Cost per Hour</th>
</tr>
</thead>
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<tr>
<td>30</td>
<td>760</td>
<td>2740</td>
<td>3500</td>
<td>362</td>
<td>36.2</td>
<td>$101</td>
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<tr>
<td>60</td>
<td>766</td>
<td>4711</td>
<td>5477</td>
<td>559</td>
<td>55.9</td>
<td>78</td>
</tr>
<tr>
<td>90</td>
<td>771</td>
<td>6682</td>
<td>7453</td>
<td>756</td>
<td>75.6</td>
<td>70</td>
</tr>
<tr>
<td>120</td>
<td>777</td>
<td>8653</td>
<td>9430</td>
<td>953</td>
<td>95.3</td>
<td>66</td>
</tr>
</tbody>
</table>

quarter of a day) to attend the conference. If we value their time at $100 a day, this travel time costs the county $75 for the three people plus any other travel costs involved. It does not take too much imagination to see that these travel costs -- especially in the hazardous driving conditions of winter -- can easily be large enough to make the interactive television system competitive with the conventional alternative. A more extensive examination of the costs and benefits of the interactive system is planned for Phase III of this research.
Appendix A

RAND RECOMMENDATIONS TO MRC

This appendix includes two lists of the most important Rand recommendations that were embodied in working notes to MRC; they are included here to serve as a check list for future system designers, builders, and users. Many other recommendations were made verbally or were included in informal communications such as letters and memos. The appendix also describes the results and progress on these recommendations when they were reviewed in November and December 1973.

Recommendations to MRC, December 1972

1. Give debugging priority over operations.
2. Consider the possibility of hiring two full-time technicians on a permanent basis.
3. Negotiate a maintenance agreement that incorporates a penalty for system downtime due to slow maintenance response.
4. Provide a backup audio system capability.
5. Consider purchasing standby power generators.
6. Consider facsimile equipment for all sites.
7. Put preview selection under the chairman's control in the WTC studio.
8. Provide ability to chair a meeting from any of the county sites.
9. Evaluate the problem of interference that might be caused by local area transmissions from the omnidirectional antennas.
10. Consider a sophisticated preview system design that would make it possible for all sites to preview all other sites simultaneously. The picture would be intermediate between still and moving, changing frames at the rate of one per second.

Recommendations to MRC, September 1973

1. Provide some kind of backup system so that in case of system failure scheduled conferences could be carried on by audio alone.
2. Equip the telephone handset now in use on the WTC control console with some kind of simplified dialing apparatus.
3. Use the split-screen capability more often.
4. Keep more complete and detailed records on all activities, particularly on equipment maintenance.
5. Obtain some data on user reactions to the teleconferencing system.
6. Sound-deaden all studios; each county studio should have sound-absorbent walls, floor, and ceiling.
7. As long as microphones must be held in the hand, take the table stands out of use.
8. Show the WTC studio on the air prior to meetings, while people are gathering.
9. Obtain a number of smaller tables for the WTC studio, preferably of the trapezoidal shape, so that various arrangements are possible.
10. Keep the second monitors in the county studios as spares or put them to other uses, but do not have them face the participants at a meeting.
11. Instruct county coordinators to make sure that participants understand they can be previewed in the WTC studios at any time. A small red tally light should be installed on the main monitor in each county studio to remind participants that they can be seen.
12. Train the camera on the person who is speaking unless there is a very good reason for showing something else.
13. Group the site selection buttons on the WTC control console together according to channels.
14. Provide a set of site selection and preview buttons in the WTC studio for the use of chairmen or MRC representatives.
15. Take a set of photographs of the television picture showing wide shots of each county studio, typical split-screen configurations, and representative shots from important meetings for use in public relations, for historical purposes, and the like.
16. Give more instruction to county operators; some kind of on-the-job training must be devised and applied.
17. Reposition the camera below the monitor on at least one of the camera/monitor assemblies, and evaluate the resulting new angle of view.
18. Place a clock in direct sight of participants in the WTC studio, preferably on the camera/monitor assembly.
19. Design an easily understandable system for labeling videotapes.
20. Construct and supply table easels to all county studios.
21. Give county operators and coordinators specific training in selecting and using visuals.
22. Disconnect the controls at county studios for activating local omni-directional transmission temporarily or disable the antennas.
23. Replace "program" and "preview" signs with something similar to the "look here" and "picture going out" signs that were first used.
Review of Recommendations: November and December 1973

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<th>December</th>
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<td>25</td>
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<tr>
<td>Out of the question financially</td>
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<td>4</td>
</tr>
<tr>
<td>Action currently under way</td>
<td>6</td>
<td>2</td>
</tr>
<tr>
<td>Action completed or procedure established</td>
<td>4</td>
<td>9</td>
</tr>
<tr>
<td>Must wait for available staff time</td>
<td>11</td>
<td>6</td>
</tr>
<tr>
<td>Can only be done by the individual counties</td>
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<td>1</td>
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</table>

<table>
<thead>
<tr>
<th>Rand Action</th>
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<td>7</td>
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<tr>
<td>Recommendation continued</td>
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<tr>
<td>Extended in scope</td>
<td>2</td>
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</tr>
<tr>
<td>Reduced in scope</td>
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<td>1</td>
</tr>
<tr>
<td>Reduced in priority</td>
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<tr>
<td>Dropped</td>
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</table>
Appendix B

FACT SHEET

The following fact sheet was distributed to possible county subscribers to the MRC-TV service sometime early in 1972. If MRC were to do it again, it would make some important changes in at least two statements they later had to rescind. The numbers attached to the following notes refer to the numbered items on the Fact Sheet.

2. This statement fails to mention the necessity, in practically all conference rooms, for sound-deadening modifications such as the installation of carpeting, the hanging of drapes or covering of walls with sound-absorbent material. Where these modifications were made, the local counties paid their cost.

4. This statement proved untrue. Not too long after the Fact Sheet went out, MRC was advised to go back to the counties and tell them that regular trained operators would be required, although they could be persons who also had other jobs to perform. After six months, most of the people who have worked as operators still show room for improvement.

5. This statement was true, but only because so little formal training was actually attempted. Next time MRC would probably prefer to hold some kind of training workshop.

The remainder of the points included in the Fact Sheet were and still are essentially true.
MUNICIPAL TELEVISION SERVICE

FACT SHEET

1. HOW MUCH SPACE WILL BE NEEDED FOR EQUIPMENT, BOTH IN THE STUDIO AND ELSEWHERE?
   A small room, approximately 15'x20' or larger, if desired, will be required for use as a "studio." In addition, a mast will be placed atop your County Building to hold the antennas required for receiving and transmitting. The transmitter itself will be housed in a small area (closet size) as close as possible to the roof.

2. WILL THERE BE ANY BUILDING MODIFICATIONS REQUIRED AND, IF SO, WHO PAYS FOR THEM?
   The only building modifications required will be the stringing of wires from the antennas to the transmitter and then to the studio. The cost of any such work is covered by the annual rental fee.

3. IS SPECIAL ELECTRICAL SERVICE OR AIR CONDITIONING REQUIRED? WHO PAYS FOR INSTALLATION?
   Any special electrical service or air conditioning that is required will be paid for by the Metropolitan Regional Council. Such work is expected to be minimal.

4. HOW MANY PERSONS WOULD NORMALLY BE NEEDED FOR THIS OPERATION?
   The system has been so designed that no additional personnel will be required to operate it. The camera to be utilized will be wall-mounted and will be operated by remote control by the individual participating in the discussion or meeting. A few minutes of training in the operation of such a remote control unit will enable all department heads and elected officials to participate in a televised meeting without anyone else in the "studio" to assist them. Additionally, we would train someone designated by the county to turn the transmitter on and off.

5. IS THERE ANY SPECIAL TRAINING REQUIRED AND, IF SO, AT WHAT COST?
   There will be no cost involved in any training.

6. WHO PAYS FOR THE MAINTENANCE AND PARTS?
   The contractual agreement with MRC covers all maintenance of equipment as well as replacement of parts. MRC is presently negotiating a contract with a company which will provide full maintenance of all equipment.

CONT...
7. **WHAT HAPPENS IF A MAJORITY OF MUNICIPALITIES WITHDRAW FROM THIS SERVICE AFTER THE TRIAL FIRST-YEAR PERIOD?**
   Based on the response received from the various local municipalities, the state governments and the Federal Government representatives, we feel that rather than a majority of them withdrawing from the service, MRC will be hard-pressed to provide service to all those agencies seeking to be connected to the system. At present, we are discussing links in Trenton, Albany, the Federal Office Building in New York City and the possibility of the Federal Government contracting with us for a direct tie-in between our system and Federal offices in Washington, D.C.
   However, each municipality is contracting with MRC for only one year at a time and in the event that any county should ever wish to withdraw from the television system it would, of course, be free to do so and the equipment would be removed from its premises.

8. **DOES A SYSTEM SUCH AS THIS EXIST ANYWHERE ELSE IN THE U.S.?**
   A system such as the one planned by MRC to serve local governments does not presently exist anywhere else. That is the reason why we have been able to attract support from private foundations and from the Federal Government. Television systems of a one-way or receive-only type are being used currently by local governments.
   Of course, the telephone company is beginning to install "picturephone" in Pittsburgh and certain other cities. However, the cost for this service is astronomical compared to our system. As an example, "picturephone" rates at present are $160 for 30 minutes, plus installation and maintenance. Thus, for a five-hour day the cost would be about $1,600 - or $8,000 per week. Within two weeks the cost would exceed that which each county will be contributing annually to the MRC system.

9. **IN THE EVENT OF AN EXPANSION OF THIS SYSTEM FROM REGIONAL TO INTER-COUNTY SYSTEM, WOULD THERE BE ANY ADDITIONAL COST?**
   No. The annual cost of $14,000 covers installation of the necessary equipment to communicate to any other point within the regional system as well as the equipment required to transmit from the county building to other locations within the county.

10. **DOES $14,000 REPRESENT A TRUE PICTURE OF THE ANNUAL COST FOR EACH LOCALITY?**
    No. The actual cost of construction, maintenance and programming is approximately $30,000 per location per year. However, due to the support of Federal agencies and private foundations, the cost has been reduced to $14,000 per year.

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**ANY ADDITIONAL QUESTIONS SHOULD BE DIRECTED TO:** Mr. Frank Strauss, Director of Communications, Metropolitan Regional Council, 155 East 71 Street, New York, N.Y. 10021. Tel. (212) 628-6803.
Appendix C

TYPICAL MEETING NOTICE

This appendix contains (1) a meeting notice and (2) an agenda. They pertain to a general interest special aired January 29, 1974, intended for a wide spectrum of government officials and administrators.
MEETING NOTICE

January 17, 1974

To: County and Municipal Government Services Administrators

Re: Meeting

Date: Tuesday, January 29th

Time: 1:00-4:00 p.m.

Topic ENERGY MANAGEMENT BRIEFING

Location: MRC-TV Local two-way television studios in New York City, Mineola, White Plains, New City, Newark, Hackensack, Linden, New Brunswick, Stamford.

Our guest speakers will be Mr. Gerald J. Turetsky, Interim Regional Director, Federal Energy Office, Mr. Angelo De Bernardo, Motor Equipment Division - GSA, Mr. Lawrence C. Forno, Vice President Budget Rent-A-Car, Mr. Robert K. Bogardus, Regional Commissioner, Public Buildings Service, GSA, Dr. Charles Lawrence, Public Utilities Spec. City of New York, Mr. Martin C. Seham, General Counsel, Committee for Adequate Supply of Energy, Mr. Arnold Gordon, General Counsel, Federal Energy Office.

Major topics to be discussed are: FUEL ALLOCATION, FUEL CONSERVATION IN GOVERNMENT BUILDINGS AND VEHICLES, AND ROLE OF FEO.

All participants will have the opportunity to join in the two-way discussion on the topic of Energy Management.

Kindly return the enclosed postcard indicating your participation and names of those who will be attending with you.

RODMAN T. DAVIS
NEW YORK CITY FEDERAL EXECUTIVE BOARD
ENERGY MANAGEMENT SEMINAR
JANUARY 29, 1974

OPENING REMARKS

GERALD J. TURETSKY
Interim Regional Director
Federal Energy Office

CONSERVATION IN TRANSPORTATION

ANGELO DE BERNARDO  LAWRENCE C. FORNO
Motor Equipment Division  Vice President
Federal Supply Service  Budget Rent-A-Car
General Services Administration

* A discussion of GSA's programs and accomplishments in reducing fuel consumption in its fleet of government vehicles.

* Suggestions on promoting energy conservation and establishing effective controls.

CONSERVATION IN BUILDINGS

ROBERT K. BOGARDUS  DR. CHARLES LAWRENCE  MARTIN C. SEHAM
Regional Commissioner  Public Utilities Spec.  General Counsel
Public Buildings Service  City of New York  Committee for
General Services Admin.  Adequate Supply

* A discussion of programs and accomplishments in reducing energy consumption in Federal Buildings.

* A report on a recently completed study by the New York City Real Estate Board concerning the consumption of energy in buildings.

* A report on the activities and accomplishments of the Committee on an Adequate Supply of Energy.

FUEL ALLOCATION

ARNOLD GORDON
General Counsel
Federal Energy Office

* An explanation of the authorities, activities and responsibilities of the Federal Energy Office.

AUDIENCE PARTICIPATION

* The panel of speakers will answer questions from the audience.
Appendix D

MRC-TV EQUIPMENT LIST

The following equipment list was submitted to MRC by Genesys in its original proposal. Some minor changes may have been made in the final complement of equipment that was installed. For those contemplating constructing and using similar systems elsewhere this list is useful in showing the range and kinds of equipment that would be needed. Prices are not given because they are subject to such frequent revision; current costs can readily be obtained from manufacturer's price lists.
## EQUIPMENT LIST: CENTRAL SITE RF

<table>
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<th>Item</th>
<th>Mfg.</th>
<th>Model No.</th>
<th>Quantity</th>
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</thead>
<tbody>
<tr>
<td>TV Transmitter</td>
<td>Varian</td>
<td>Micro-link MES 402-B</td>
<td>1</td>
</tr>
<tr>
<td>Dehydrator/Pressurizer</td>
<td>Andrew</td>
<td>55690</td>
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<td>Antenna (Omni)</td>
<td>Andrew</td>
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<tr>
<td>Antenna Mounts</td>
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<td>Power Tap</td>
<td>Micro-link</td>
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<tr>
<td>Transmission Monitor</td>
<td>Genesys</td>
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<td>2 Position Coax Switch</td>
<td>Genesys</td>
<td>CE-5C, CE-5P</td>
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<tr>
<td>with Driver, Power</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Supply and Controls</td>
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<tr>
<td>Down Converter</td>
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<td>Receiver and Mount</td>
<td>Genesys</td>
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<tr>
<td>Overhead Camera w/Vidicon</td>
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<td>Roll, Pan, Tilt - Silent</td>
<td>Pelco/Genesys</td>
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<td>Zoom Lens 15 - 150 mm, f 2.8</td>
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<td>V10X15RLO</td>
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<td>2:1 Extender</td>
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<tr>
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<td>Pan/Tilt - Silent</td>
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<td>CCU</td>
<td>GPL</td>
<td>995</td>
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<td>VR622</td>
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<td>Remote Control - VTR</td>
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<td>Remote Control - Zoom/Roll/Pan/Tilt</td>
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<td>Remote Control - Film Chain</td>
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<td>AC Power Distribution</td>
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<td>Custom</td>
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<tr>
<td>Lighting Control Panel</td>
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<tr>
<td>Audio/Video Talkback Control</td>
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## Equipment List: Two-Way Site RF

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<thead>
<tr>
<th>Item</th>
<th>Mfg.</th>
<th>Model No.</th>
<th>Quantity</th>
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<tr>
<td>Transmitter, 10W</td>
<td>Varian Micro-Link</td>
<td>MES 402-B</td>
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<tr>
<td>VHF Modulator</td>
<td>Dynair</td>
<td>TX-4A</td>
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<tr>
<td>Omni Antenna</td>
<td>Andrew</td>
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<tr>
<td>Dish Antenna (6')</td>
<td>Andrew</td>
<td>P6-24</td>
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<tr>
<td>Antenna Mount</td>
<td>Andrew</td>
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<tr>
<td>Tower (30'-100')</td>
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<td>Transmission Line and Fittings</td>
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<td>Pressurization (Nitrogen)</td>
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<td>Coax Switch</td>
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<td>Waveguide/Coax Adapter</td>
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<td>WCE-7</td>
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<td>Genesys</td>
<td>7006-6</td>
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<td>Dummy Loads</td>
<td>Micro-lab</td>
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<td>Directional Coupler</td>
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<td>Waveguide Power Tap</td>
<td>Micro-link</td>
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<td>Down Converter</td>
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<td>Overhead Camera w/Vidicon</td>
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<td>Roll, Pan, Tilt - Silent</td>
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<td>Zoom Lens 15-150 mm, f 2.8</td>
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<td>2:1 Extender</td>
<td>Canon</td>
<td>EX 2.0A</td>
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<td>CCU</td>
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<td>Audio Mixer</td>
<td>Shure</td>
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<td>Audio Monitor and Distribution Amplifier</td>
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<td>Installation Material</td>
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</table>
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* Bibliography is listed in chronological order so that the reader may easily find the most current literature.


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